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Private provision of public goods and asset prices

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Preface

I am indebted to several people who have advised, supported, encouraged, and criticized me through the research and writing process of this thesis. First and foremost, I would like to thank my supervisor, Lucas Bretschger, for his generosity, patience, guidance and encouragement. Having him as a supervisor was a great pleasure and privilege. The atmosphere at his chair was always very inspiring and collaborative. The social events of the RESEC group are memorable and indicative of the team spirit. I warmly thank the RESEC staff and also former RESEC members for contributing to such a stimulating and pleasant work place.

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Writing this thesis was a desktop adventure and I enjoyed it. This is also due to my great friends and family who have always been of immense support and enrichment to my life.

Zurich, December 2013 Janick Christian Mollet

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Thesis summary

In capitalist societies it is the role of the state to establish the preconditions that promote societal well-being through proper functioning markets. On the other hand enterprises have a right to provide goods and services in return for private profit. This sharp contrast between government and corporate responsibilities is created by a theoretical idealized first-best world. Only governments have the legitimacy and the power to overcome free riding and collective action problems which cause market inefficiencies such as negative externalities and underprovision of public goods. With this classical dichotomy between state and corporate responsibilities in mind, at first glance it seems puzzling that some firms also seem to provide public goods. They offer goods and services or operate in a manner which can be characterized as the private provision of public goods.

This thesis asks how information about the voluntary private provision of public goods, also known as corporate social responsibility (CSR), affects asset prices. Since the stock market has a disciplining effect on corporations, stock price reactions capture the possibilities and limits of voluntary corporate action. The thesis proposes some answers to the question of whether corporate acts that do primarily benefit stakeholders without share ownership are against the interest of shareholders, and, if so, under which circumstances.

The first chapter starts with a broad introduction to the topic. It discusses the role of government on the basis of welfare theory and market failures. In addition, it emphasizes the moral dimension of voluntary action and explains the link between the private provision of public goods and CSR. Because the

thesis studies asset price reactions, relevant finance concepts are introduced. Furthermore, the ambition and contribution of the thesis is outlined. The first chapter gives short summaries of chapter two to five and offers a primer on portfolio theory to foster understanding of the last two chapters. It closes with a description of the findings and discusses their implications.

Chapters 2 and 3 contribute to the literature on voluntary firm action by introducing the role of regulatory pressure for asset price reactions. Both chapters study corporate efforts to reduce carbon emissions. Chapter 2 asks whether the carbon intensity of a firm carries any information on its growth opportunities as measured by Tobin's Q. Panel regressions that account for unobserved firm heterogeneity and autocorrelation, tackle this question by using carbon emission data on the global firm level. In order to obtain insight into the role of regulatory pressure for the relationship between carbon intensity and Q, two countries with different regulatory regimes are juxtaposed.

Chapter 3 explores one specific motivation for firms to join voluntary environmental agreements: the anticipation of more restrictive future regulation. The research design explores in an event-study stock market reactions for firms in two popular corporate climate initiatives, when the likelihood for stricter federal carbon emission regulation suddenly increases. Additionally, the market reactions for membership announcement in these initiatives are evaluated and discussed.

The last two chapters investigate whether voluntary investment screens used in socially responsible investing (SRI) have any implications for financial performance. These two chapters are complementary and analyze the risk adjusted return performance of synthetically constructed portfolios that are unaffected by skill or luck of asset managers. Chapter 3 analyzes portfolios of high market capitalization firms from Europe and the United States. Even though firms from many industries are excluded in the screening process, the risk adjusted returns for these SRI portfolios are neutral in both markets. In Chapter 4 a distinct portfolio of small European growth firms with an inno-

vative strategic CSR implementation is put to the test. Bad model problems prevalent for portfolios with the observed characteristics are addressed by using a novel robustness check and the finding of positive abnormal performance obtained by conventional methods is confirmed. It is argued that two different hypotheses, one of them under appreciated in the literature, might be responsible for this apparent market inefficiency.

Kurzfassung

In marktwirtschaftlich organisierten Gesellschaften ist es Aufgabe des Staates, für die Rahmenbedingungen zu sorgen, die sicherstellen, dass das Wirken der Marktkräfte zur gesellschaftlichen Wohlfahrt beiträgt. Unternehmen auf der anderen Seite dürfen durch die Bereitstellung von Gütern und Dienstleistungen private Profite machen. Diese theoretisch idealisierte Sichtweise impliziert dichotome Verantwortungsbereiche zwischen Staat und Unternehmen. Nur die Regierung verfügt über die nötige Legitimität und Macht, um Trittbrettfahrerprobleme und Probleme des kollektiven Handelns zu überwinden, um Marktineffizienzen wie negative Externalitäten und die Unterversorgung von Gemeinschaftsgütern zu beheben. Aus Sichtweise der klassischen Dichotomie erstaunt es, dass auch Unternehmen Gemeinschaftsgüter bereitstellen. Sie bieten Güter und Dienstleistungen an oder arbeiten in einer Weise, die als private Bereitstellung von öffentlichen Gütern interpretiert werden kann.

Diese Doktorarbeit untersucht, ob Informationen über die freiwillige Bereitstellung von öffentlichen Gütern, auch corporate social responsibility (CSR) genannt, Vermögenspreise beeinflussen. Da Aktienmärkte einen disziplinierenden Effekt auf Kapitalgesellschaften haben, zeigen Aktienpreisreaktionen Möglichkeiten und Grenzen freiwilligen unternehmerischen Handelns auf. Die vorliegende Arbeit gibt Antworten auf die Frage, ob unternehmerisches Handeln, welches auf den ersten Blick primär den Stakeholdern ohne Aktienbesitz dient, gegen die Interessen der Anteilseigner ist und gegebenenfalls unter welchen Bedingungen.

Das erste Kapitel bietet eine Einfürung in das Thema. Es erläutert

auf Basis von Wohlfahrtsökonomie und Marktversagen die Rolle des Staates und betont die moralphilosophischen Implikationen von freiwilligem Handeln. Ferner wird der Zusammenhang zwischen der öffentlichen Bereitstellung von öffentlichen Gütern und CSR aufgezeigt. Da die Dissertation Preisreaktionen untersucht, präsentiert Kapitel 1 die relevanten finanzwissenschaftlichen Konzepte und arbeitet Ziel und Beitrag der Thesis heraus.

Kapitel 2 und 3 untersuchen Aktienpreisreaktionen im Zusammenhang mit freiwilligem unternehmerischem Handeln und vertiefen dabei die Rolle des regulatorischen Drucks. Beide Kapitel fokussieren auf unternehmerische Anstrengungen, um Kohlendioxidemissionen zu reduzieren. Kapitel 2 fragt, ob die Kohlenstoffintensität einer Aktiengesellschaft Schlüsse über deren Wachstumsmöglichkeiten, gemessen mit Tobins Quotient, zulassen.

Kapitel 3 erforscht eine mögliche Motivation, warum Unternehmen freiwilligen Umweltprogrammen beitreten: Das Antizipieren strengerer Regulation. Das Forschungsdesign nutzt die unerwartete Wahrscheinlichkeitserhöhung der bundesstaatlichen Regulierung von Kohlendioxidemissionen, um die Aktienmarktreaktionen für Mitglieder in zwei klimafreundlichen Initiativen in einer Ereignisstudie zu eruieren. Zudem werden die Marktreaktionen für Mitgliedschaftsankündigungen in diesen Initiativen methodisch einheitlich untersucht.

Die letzten zwei Kapitel prüfen, ob die freiwilligen Investitionsbeschränkungen bei ethischen Investitionen das finanzielle Ergebnis beeinflussen. Diese zwei Kapitel analysieren die risikobereinigten Renditeergebnisse von synthetisch konstruierten Portfolien und sind daher nicht beeinflusst durch Können oder Glück des Anlageverwalters. Kapitel 4 untersucht Portfolien von Firmen mit einer hohen Marktkapitalisierung für den europäischen und nordamerikanischen Aktienmarkt. Obwohl Unternehmen in zahlreichen Industrien im ethischen Anlageauswahlverfahren heraus gefiltert werden, sind die risikobereinigte Renditen für diese Portfolien neutral. In Kapitel 5 wird das Renditeergebnis eines Portfolios bestehend aus kleinkapitalisierten europäischen Wachstumsfirmen mit einer innovativ-strategischen CSR Imple-

mentierung geprüft. Da Modellprobleme bekannt sind für Portfolien mit den beobachteten Charakteristiken, wird in einem neuartigen Verfahren die Robustheit der Resultate inspiziert. Die Resultate bestätigen das Vorliegen positiver abnormaler Renditen. Ferner wird aufgezeigt, dass zwei unterschiedliche Hypothesen für die beobachtete Marktineffizienz verantwortlich sein könnten.

Chapter 1

Introduction

In a world dominated by mercantilist thinking, Adam Smith formulated in 1776 the concept of the invisible hand. This Smithian idea states that individuals in the pursuit of their self interest also endorse the public interest. To date, market systems navigated by a myriad of self-interested participants have created a lot of wealth. The Malthusian reasoning that population growth is limited due to constrained food production was disproved by the rapid economic growth in the 20th century. Malthus (1798) proposed at the end of the 18th century that population growth has to be restricted in order to maintain per capita production levels. Economists have identified several key factors explaining on the one hand the wealth explosion in the 20th century and on the other the high cross sectional variation in growth rates. The first neoclassical growth models explained differences in income per capita by using different paths of factor accumulation. The causes of the different growth paths such as saving rates, preferences or technology (total factor productivity) were exogenously given (Solow, 1956; Cass, 1965; Koopmans, 1965). Later models incorporated spillovers and found that steady-state growth can be sustained by positive externalities from physical or human capital accumulation (Romer, 1986; Lucas, 1988). The next generation of models was pioneered by Romer (1990) and endogenized steady-state growth and technical progress.

The view that the economy is not independent but a subsystem of the larger ecosystem gained popularity in the seventies. In 1972 the report "Limits to Growth" for the Club of Rome spurred controversy (Meadows et al., 1972). The authors of the report pointed out that decreasing levels of exhaustible resources and increasing pollution will challenge economic growth prospects. Two years later, the theoretical growth models of Dasgupta and Heal (1974), Solow (1974) and Stiglitz (1974a,b) emphasized that with exhaustible resources as production inputs, key determinants of long term growth are the elasticity of substitution between them and other inputs, (resource-augmenting) technical progress, and increasing returns to scale. To date, economic growth has raised living standards and reduced poverty, but it has been historically very dependent on fossil fuels. A decoupling is needed in order to mitigate global warming caused by the accumulation of carbon dioxide emissions in the atmosphere. Otherwise, irreversible warming processes will cause substantial and unevenly distributed adaptation costs (IPPC, 2007).

The pressing issue today is not the exhaustion of fossil fuels but rather pollution. In order to limit global warming to less than two degrees, less than half of the proven and economically recoverable fossil fuel reserves can still be used for combustion (Meinshausen et al., 2009). If limited global warming is a serious policy goal, fossil fuel reserves on the books of governments and firms have to be valued differently (Carbon Tracker Initiative, 2011). But so far, a global climate agreement has not yet been achieved. Instead, several countries have taken unilateral action by setting standards, introducing taxes or cap and trade systems and by promoting voluntary emission reductions. If firms voluntarily reduce emissions, they mitigate a negative externality, say, a public bad. The present thesis investigates the potential for voluntary provision of public goods by firms from a stock market perspective, thereby emphasizing carbon emission reductions. The focus of the thesis is on how the stock market values information related to the private provision of public goods.

The next section discusses the economic view of the role of governments, markets, and why the concept of voluntary action is powerful. Subsequently, some theoretical issues in the private provision of public goods, also called corporate social responsibility (CSR), are examined in a separate section. The following short overviews on financial markets and asset prices lead to the discussion of the ambition and contribution of the thesis. The next sections summarize the four papers that constitute the subsequent chapters of this dissertation. Because the last two papers are portfolio analyses, they are preluded by an introduction to portfolio theory. The last section of this chapter finishes with the findings and implications of the thesis.

1.1 Welfare theory and market failures

Microeconomists have put a lot of effort into the search for the theoretical conditions under which the concept of the invisible hand is valid. This quest culminated in the formulation of the two fundamental welfare theorems attributed to Kenneth Arrow (1951) and Gerard Debreu (1959). The first welfare theorem states that a pareto efficient competitive equilibrium allocation results under some conditions if self-interested market participants act perfectly competitively in a complete set of markets. The second welfare theorem establishes the converse by showing that any Pareto efficient allocation can be attained through the price system, given some convexity restrictions. When Pareto efficient outcomes cannot be achieved, economists like to speak of market failures. According to Stiglitz (1991), the major contribution of Arrow (1951) and Debreu (1959) was to show the limitations of the concept of the Smithian invisible hand. Since the economic yardstick for policy recommendation is efficiency, the identification of market failures justifies government interventions in order to attain Pareto improvements. The aspirations to the ideal state of the economy with a maximized social product has therefore important ramifications for the perception of the role of government.

Early discussions of market failures focused on natural monopolies, externalities and public goods (Stiglitz, 1991). An externality constitutes a direct effect of a market participant's decision on another market participant that is not a party to that decision. A prime example for a negative externality is environmental pollution as a byproduct of production. In the traditional view an externality is internalized by taxing the emitter or by making him liable for his activity. The tax that induces complete internalization of an externality is called Pigouvian tax. Coase (1960) critiques in "The problem of social cost" that most economists have adopted the Pigouvian approach. He points out that if transaction costs are sufficiently low, parties affected by an externality can find an agreement maximizing the social product if property rights are well defined and enforceable. Stigler dubbed this reasoning the Coase Theorem (Coase, 1988). But Coase (1960) never believed that market exchange has zero transaction cost, because he wrote earlier, in 1937 , that firms exist due to transaction costs. His critique was that in a world with zero transaction costs, as often assumed in economic models, a Pigouvian tax is obsolete because private costs equal social costs. However, this Coasian view highlights that externalities can either be internalized by taxes, quotas, or by fostering bargaining over the extent of the externality when transaction costs are sufficiently low. The latter solution is less intrusive but, as every transaction, requires well defined and enforceable property rights. Crucially, the role of government as an enabler of Pareto improvements should therefore depend on the institutional context.

The provision of public goods also justifies government intervention. These goods are characterized by a high degree of nonexcludability and nonrivalrous consumption. Since nonpayers cannot be excluded from consumption of existing public goods, free-riding causes an undersupply of these goods in the first place. Textbook examples for public goods are national defense, fireworks and lighthouses. Coase (1974) attacks the assumption that lighthouses can only be provided by the government as proposed by famous economists (Mill, Sidgwick, Pigou, Samuelson). In detail he describes how private individuals

and organizations played a vital role in providing lighthouses in nineteenth century Britain. The authority that built and maintained lighthouses, Trinity House, operated in 1820 just 24 lighthouses, while private individuals and organizations operated 22. Coase (1974, p.375) concludes that "The role of the governments was limited to the establishment and enforcement of property rights in the lighthouse." The potential for market failure reductions by this approach is supported by the increasing trend at the end of the twentieth century toward contracting delivery of public good and services to the private sector and public-private partnerships (Besley and Ghatak, 2001). To sum up, government intervention can remedy the supply of public goods by quantity or price based interventions as well as by defining individual property rights in some cases. For policy recommendation, accounting for the institutional context is fundamental.

Although the first-best world perspective establishes the classical dichotomy between government and profit maximizing enterprises, there is no unique and generalizable view of the role of government from an efficiency perspective. Lipsey and Lancaster (1956) argue that reality never satisfies simultaneously the first-best conditions of the welfare theorems. They show that if one Pareto optimum condition can not be attained due to some constraints, trying to satisfy the other Paretian conditions is no more desirable. The authors (p.12) summarize their findings as "The general theorem of the second best states that if one of the Paretian optimum conditions cannot be fulfilled a second best optimum situation is achieved only by departing from all other optimum conditions". However, policy recommendations referring to the second best theorem should not be reduced to stating that because the ideal market is a fantasy, an ideal government should fix outcomes. Aside from inconclusive formal theories, arguments in support of market systems are that they work better than any known alternative to coordinate economic activity. Markets do this relatively efficiently by producing price signals that contain some relative scarcity information (Lipsey, 2007).

1.2 Moral implications of voluntary action

Moral philosophy offers arguments in favor of market systems. Market systems promote autonomy and individual freedom (Hausman and McPherson, 2010). An (ideal) market transaction is executed voluntarily and is therefore less intrusive than freedom limiting state regulation with the inherent tendency to increase the reach of government. Judging an action or inaction as voluntary has far reaching moral consequences. Illustrative of the implied consequences is the controversy spurred by the claim of new classical economists that unemployment is such as any other economic choice (Lucas, 1978). In their view unemployed workers merely choose voluntarily to consume more leisure instead of working. Opposed to this voluntary unemployment argument is a Keynesian market view. With market imperfections like rigid wages, employment and not the wage adjusts to clear the market after disruptions, producing unemployment in equilibrium. Hausman and McPersons (2006, p.36) give a more nuanced definition for voluntary choice: "..., whether a choice is 'voluntary' depends both on the quality of the alternatives and on the circumstances bringing about the occasion for choice."

Overall, good reasons exist to be supportive of a market system. It promotes autonomy and individual freedom and seems to be the least bad system from an efficiency perspective. In the presence of mutual benefit market transactions occur voluntarily, creating win-win situations. Libertarians favor voluntary action because they judge government interventions to be coercive. The more the course of action is influenced by mandatory governmental formal rules, the less this action is voluntary. The appeal of voluntary over coerced action is rooted in moral philosophy and the argument that it produces less private costs. However, an efficiency assessment of coercive regulation should not only account for private costs but also for social benefits.

1.3 Private provision of public goods and CSR

This thesis investigates voluntary action in the market place contributing to the common good. The initiatives studied might also be viewed as acts of corporate social responsibility (CSR). Heal (2005, p.1) defines CSR as "... program of actions taken to reduce externalized costs or to avoid distributional conflicts. It is an institution that has evolved in response to market failures, a Coasian solution to some problems associated with social costs." Within the classical dichotomy view, CSR seems to invade undisputed government tasks of correcting market failures. However, in a second-best world CSR can contribute to welfare improvements. But CSR can only achieve second-best levels of public good provision (Kitzmueller and Shimshack, 2012). Besley and Ghatak (2007) show that CSR has the greatest institutional advantage in providing a public good, when the public good is naturally bundled with the production of a private good. They identify CSR " ... with the creation of public goods and curtailment of public bads jointly with the production of private goods".

In general, most firms seek the goodwill of employees, shareholders, financial institutions, neighboring communities, local governments, and citizens. Ultimately, all stakeholders have options to influence the business operations of a firm directly or more indirectly, through social pressure or the regulatory framework. Strategic CSR is according to Baron (2001), either induced by demand side pressure or a hedging strategy against the risk of activism or future regulation. For Friedman (1970) the socially responsible purpose of a firm is to maximize its profits. After all, investors can decide for themselves to donate excess profits. Yet this view has the drawback of allowing only for end-of-pipe solutions even if problems might be avoidable in the first place.

Tirole (2001, p.1) identifies three stumbling blocks on the way to a stakeholder society: "The implementation of the stakeholder society strikes three rocks: dearth of pledgeable income, deadlocks in decision-making, and lack of

clear mission for management." Tirole argues that poorly defined stakeholder priorities and objectives can hamper good governance. Good governance mechanisms are needed in order to minimize dysfunction in corporations related to the delegation of tasks from a principal to an agent. Good governance should reduce moral hazard, inefficient investments, self dealing, and guarantee an effort level in the interest of the principal (Tirole, 2006). But whereas CSR to satisfy manager preferences might constitute moral hazard, CSR to satisfy nonclassical preferences of investors, employees, and consumers does not (Kitzmueller and Shimshack, 2012). Firms might also take the interests of various stakeholders into account to the degree that this serves profit maximization. This shareholder value definition with a broad set of factors to be considered in the maximization process is also called instrumental stakeholder theory (Jones, 1995).

1.4 Financial markets and CSR

This thesis asks whether corporate action directed at stakeholder interests, by providing public goods or reducing public bads, is detrimental to shareholder value. Shareholder value is key for investors with classical preferences. These investors derive utility exclusively from pecuniary benefits. Moreover, institutional investors are usually subject to a fiduciary duty and therefore mandated by law to care about shareholder value.

The value of an asset is its price, such as the stock price, and the return of an asset incorporates information about the development of the asset price over time. Asset prices are the result of heterogeneous valuations of time, risk and beliefs (Hens and Rieger, 2010). Equity prices contain important fundamental information. Corporate investments and the stock market are positively correlated. The traditional explanation for this is that stock prices reflect the marginal product of capital (Baker et al., 2003). Barro (1990) finds that the stock market has substantial explanatory power for investments. The stock market also determines the cost of funds and influences external

financing. These effects impact the weighted average cost of capital (WACC) of a firm and therefore corporate investments (Wall, 1995). Furthermore, stock markets can exert pressure on managers because managers have to cater to investors' opinions to avoid forced removal or takeover (Randall et al., 1990). Firms with good corporate governance usually design compensation systems so that executives are incentivized to care about the stock market value of their firm (Hartzell and Starks, 2003). Theorists argue that financial markets and institutions reduce the firm's cost of raising money from outsiders by helping a firm overcome problems of moral hazard and adverse selection. In this sense, Rajan and Zingales (1998) show that financial development, typically measured by the level of credit and the size of the stock market, has a substantial supportive influence on the rate of economic growth.

Different notions about the efficiency of financial markets exist. Under the efficient market hypothesis (EMH), the market is efficient with respect to an information set if asset prices are fully reflective of that information set. The semi-strong EMH states for instance that all public information is reflected in the stock price (Fama, 1970). But market efficiency per se is not testable because it must be tested jointly with some equilibrium model, say, an asset pricing model. This gives rise to the joint hypothesis problem because the interpretation of anomalous evidence is ambiguous: Either the market is not efficient or the wrong equilibrium model has been used (Fama, 1991). Grossman and Stiglitz (1980) add an equilibrium degree of disequilibrium to the efficient market concept by declaring that security prices only capture fully all available information if information and trading costs are zero.

In support of the EMH are short run return predictability tests. The predictability of short run returns is so weak that exploitation is not possible in the presence of trading costs (e.g. Fama and Blume, 1966). Short run returns basically follow a random walk. On the other hand, long-run volatility tests are harder to reconcile with the concept of efficient markets (Shiller, 1981b,a). But, in contrast to short-run return tests, these tests have to deal with the joint-hypothesis problem because expected returns vary substantially through

time (Fama, 1991). However, investors might not be as rational as assumed in the EMH. Psychologists and later behavioral economists have identified empirical flaws in the concept of rational human behavior (Kahneman, 2012). But in order to observe irrational asset prices either rational market participants have to be inexistent or institutional constraints forestall efficient arbitrage activities. Otherwise, arbitrage activities by rational investors eliminate mispricings and irrational investors run out of money. To date, seemingly extreme mispricings in the form of so called asset bubbles can only be rationalized ex-post after they have burst. Because these bubbles are rare, there is so far no statistical evidence that reliable identification of sustained divergence of cumulative returns from equilibrium returns is possible.

This thesis takes the perspective that to date evidence favors more the view that prices sometimes deviate from fundamentals, but exploitation is very difficult. After all, relative efficiency of financial markets is a more useful concept than the all or nothing view (Campbell et al., 1996).

1.5 Ambition and contribution of the thesis

The previous sections emphasized the virtuous nature of voluntary market exchange and identified from an economic perspective situations when some kind of government intervention is needed. I discussed that the idealized first-best world implies a clear dichotomy between governmental and private sector tasks but that the real world contradicts this view. Moreover, numbering social benefits from public good provision or reduction of public bads has the potential for controversy, whereas quantification of increased short-run private costs through regulatory changes is less ambiguous. These obstacles and coordination issues, for instance in addressing global problems such as climate change, can result in political stalemate. As a consequence, insufficient or no regulatory steps are taken and public goods are undersupplied or public bads (negative externalities) not sufficiently reduced. Coase has suggested that small intrusive government interventions that rely on mar-

ket forces might attain in certain circumstances Pareto improvements in the presence of market failures. My thesis empirically researches that claim for certain cases. It sheds light on the potential role of publicly listed firms in the private provision of public goods from a stock market perspective. The subsequent chapters ask how information about the private provision of public goods is gauged by the stock market. This question is not only relevant for investors but also for the real economy because asset prices convey important information, as argued in the previous section. Therefore, the findings and their interpretation have policy implications. My thesis applies state of the art empirical techniques and tackles the general research question by using different methodological approaches.

The first two papers extend the literature by focusing on the interplay between voluntary greenhouse gas reduction efforts and regulatory pressure. Because a first-best global regulatory solution to the looming public bad caused by climate change is out of sight and also unilateral regulation often faces opposition, the chosen focus gains particular relevance.

The last two papers investigate portfolios of CSR firms and therefore adopt more an investor perspective. Over the last two decades socially responsible investing (SRI) has gained substantial market share and various investor initiatives have been created to pressure firms to pursue good environmental conduct. Even the United Nations became active in the field and initiated in 2006 the Principles for Responsible Investment. Yet asset screens used by SRI could lead to suboptimally diversified portfolio composition. The analyzed portfolios are constructed with the help of SRI ratings from a Swiss bank. The synthetic constructed portfolios have distinct characteristics and the papers address some neglected theoretical issues.

1.6 The carbon-intensity paper

Pollution Release and Transfer Registers ensure transparency about emissions from facilities and plants above a certain threshold. They have become pop-

ular around the world and some researchers even regard them as a policy tool for environmental protection (Khanna et al., 1998). This study systematically surveys the empirical literature on eco-efficiency and identifies the distinct characteristics between toxic and carbon emissions. Then cost reducing and revenue increasing arguments with regard to a firm's global carbon-intensity are discussed. I make the distinction between two types of cost sources in this paper. Regulatory costs are related to regulatory interventions or downside risks related to future government interventions, while inherent costs are principally driven by the development of input prices.

The relevance of these two cost sources is evaluated by investigating whether, depending on the regulatory context, the global carbon-intensity of a firm has any relationship to its financial performance as measured by Tobin's Q. The use of global firm level emissions in a panel is unique and possible due to a recently developed emission accounting standard. Based on a comprehensive overview of related micro econometric studies on the firm level, I justify my battery of control variables. In the model formulation attention is devoted to the construction of Q in order to avoid a look-ahead bias.

To understand the role of regulatory pressure, I estimate firm valuation models for two regions with different regulatory frameworks. The firm panels for the time period 2003 to 2007 account for firm heterogeneity and autocorrelation. The study analyzes firm panels in the United States (US) and the United Kingdom (UK) because both countries have well developed stock markets but different regulatory environments. Whereas in the UK legislation governs carbon emissions and the continuation and potential tightening of the regulatory scheme has been signaled, federal legislation is missing in the US. The study finds evidence for a negative relationship between carbon intensity and Q in both markets, however, twice as large in the United Kingdom. Put differently, an increase in carbon intensity has about twice the penalty in terms of Q in the United Kingdom and vice versa, a decrease twice the reward. These results highlight the role of regulatory pressure for

that markets reward climate friendly behavior. Moreover, they suggest that rapidly rising input prices, the oil price for instance has tripled during the study period, help steer markets towards greener behavior.

1.7 The Waxman-Markey Bill paper

In this paper we explore one crucial motivation for firms to join voluntary environmental programs (VEP). The membership in VEP sends a credible signal to different stakeholders but can also be instrumental in preparing for anticipated future regulation. We study whether publicly listed members of two popular climate initiatives are rewarded for their engagement when the likelihood for the imposition of a federal carbon emission trading system suddenly increases. The paper builds on two closely related studies that investigate aspects of the Chicago Climate Exchange (CCX) and the Climate Leaders (CL) program. The study of monthly returns for CCX membership in a difference-in-difference approach and by Gans and Hintermann (2013) and CL membership announcement returns investigated by Fisher-Vanden and Thorburn (2011) in an event-study. Our paper integrates these two study subjects and standardize the statistical methods to explore the effect of the narrow passing of H.R. 2445, the "American Clean Energy and Security act of 2009" by the US House of Representatives. We argue that the passing of this bill on 26, June 2009, also dubbed Waxman Markey Bill, lends itself exceptionally well for an short-horizon event study analysis.

We find for both samples positive short horizon abnormal returns in the light of this unexpected regulatory event. However, when we control for industry affiliation of the corporate members in these VEPs, only positive significant results remain for the CCX sample. To understand theses differences, it helps to know that the CCX can be considered as a blueprint for the cap and trade emission system proposed in the bill. The CL program on the other hand was solely focused on cost effective GHG reductions of its members. Although the program enjoyed a good and credible reputation because

it was harbored by the Environmental Protection Agency, it was not judged to be of considerable advantage against the backdrop of the introduction of a cap and trade system. In fact, Fisher-Vanden and Thorburn (2011) find negative announcement returns for firms joining the CL program and for firms announcing reduction target. They argue that firms with hostile shareholder governance were more likely to join CL in the first place. However, we also investigate with the event-study methodology the announcement returns for CCX membership and find no stock market reaction whatsoever. Based on our findings we conclude that it pays to be green in the tangible presence of regulatory pressure. However, the efforts to be green need to correspond to the envisioned regulatory design favored by the government for possible implementation.

1.8 Portfolio analysis: 2 complementary papers

I start this section with a short primer on portfolio theory and empirical applications because the last two papers deal with firm portfolios.

The importance of the covariance among securities for portfolio construction was realized by Markowitz (1952). Markowitz (1959) also laid the groundwork for the Capital Asset Pricing Model (CAPM) with his insight that a mean-variance efficient portfolio offers the highest expected return for a given level of variance. That implies for investors that non-systematic risk can be eliminated by holding a well diversified portfolio. Therefore, investors should only demand compensation for systematic risk, say, risk that can not be eliminated by holding a well-diversified portfolio.

The CAPM was developed by Sharpe (1964), Lintner (1965) and Mossin (1966). It states that if investors are homogeneous and share a common subjective joint distribution of rates of return means, the market portfolio is the mean-variance efficient portfolio. An issue for empirical CAPM tests

identified by Roll (1977) is the unobservability of the true return on the market portfolio and that instead a proxy has to be used. But as long as there is reason to believe that the correlation between the true market return and the proxy is high, this problem is attenuated. Moreover, Stambaugh (1982) shows that the CAPM is not sensitive to the proxy used. However, the CAPM has been challenged by the empirically driven anomalies literature. Using a two-step approach to deal with the problem of cross-sectional correlation, Fama and MacBeth (1973) find that CAPM betas indeed explain differences in expected returns across stocks. That the intercept in the regression proved to be larger than the risk-free rate was, however, inconsistent with the CAPM. Various other CAPM anomalies established that stock characteristics are related to differences in expected returns. Banz (1981) found that size helps to explain expected returns. Various other anomalies are related to scaled versions of the inverse of the stock price. The price-earnings ratio has marginal explanatory power for expected returns (Basu, 1977) and leverage is positively related to expected returns (Bhandari, 1988). Chan et al. (1991) and Fama and French (1992) find that book-to-market equity has strong return explanatory power. Motivated by these systematic anomalies, Fama and French (1993) propose a CAPM model extended by two additional factors. They add long-short portfolio returns from going long in small market value and shorting big market value firms. To this"small-minus-big" (SMB) factor they add long-short portfolio returns for "high-minus-low" (HML) book-to-market ratio stocks. This so called Fama-French three factor model proved to be much more robust in empirical applications than the CAPM. Based on the momentum anomalies established by DeBondt and Thaler (1985) and Jegadeesh and Titman (1993), Carhart (1997) suggests to use momentum as a fourth factor. The momentum factor, resulting from going long in stocks with high past returns and shorting stocks with low past returns, is now commonly added to the Fama-French benchmark model. This model is called the four-factor model.

1.8.1 Big firms

Portfolio analyses for markets outside the United States are rare because until recently, Fama-French factors have been available only for the US market. In this study we analyze US as well as European SRI portfolios based on ratings obtained from a Swiss Bank. The rating process starts with a universe of large capitalization stocks and in a first step certain industries are excluded in a negative screening process. The firms in the remaining industries are then screened for good environmental, social, and governance performance. For the portfolio analysis from 1998 to 2009 we use and present a recently constructed financial databank comprising the common market return, size, value, and momentum factors (Schmidt et al., 2011). We find that SRI is associated with large-sized firms and that this investment strategy generally leads to insignificant abnormal returns when all four risk factors are considered. These results indicate that markets work fairly efficiently for large capitalization stocks. These stocks are usually very liquid and have high analyst coverage. Potential concerns by investors that negative screens cause suboptimal diversification and therefore subpar performance are refuted by our results. From this perspective, the result of neutral performance in both markets might indicate that the positive screening process did identify some value relevant firm characteristics.

1.8.2 Small and middle sized firms

In this study we analyze portfolios of strategic CSR firms in Europe. These firms are mainly small growth stocks with a focus on strategic CSR innovation. The share of firms in renewable energy and alternative electricity in this portfolio is for instance relatively high. We find for this distinct portfolio abnormal returns, say, a significantly positive alpha (intercept). Notwithstanding the general empirical robustness of the four-factor model, it is known that bad model problems are more frequent for portfolios of small growth

stocks. This gives rise to the joint hypothesis problem. Therefore, we use in a robustness check a novel propensity score matching method to construct control portfolios with similar characteristics. We then estimate four-factor models for these portfolios in order to compare the alphas of the SRI portfolio to similar control portfolio alphas. Although in expectation the alpha should be zero, we find positive alphas for the control portfolios in a resampling procedure. But the alpha of the SRI portfolio outperforms the control portfolios by about 1% monthly.

We argue that two explanations lend themselves to positive abnormal returns for this portfolio. They are the strategic CSR implementation of the firms and the strong growth in SRI during the analyzed period from 2003 to 2009. This last point has so far not received attention in the literature. With the available data we can not distinguish if the alpha was driven by a transition to a new equilibrium induced by a demand shift, or because of a systematic underestimation of the expected fundamental performance. Furthermore, the rolling alpha estimation also shows no trend that would distinguish between the two hypotheses. There is, however, one caveat for the implementation of the analyzed investment strategy. It would be somewhat less attractive than the positive abnormal performance identified in this study because research and transaction costs can be substantial for small stocks given their limited capacity to absorb funds.

1.9 Findings and implications

This thesis finds no evidence that firms engaging in the provision of public goods act against the pecuniary interests of their shareholders, rather the contrary. Firms that practice CSR perform at least as well or better than one would expect. Overall the results are supportive of the instrumental stakeholder theory. Because one can argue that within a separating equilibrium some firms provide public goods to stakeholders while others do not, this finding does not necessarily imply that firms should generally engage more

with their stakeholders.

The papers on the interplay between voluntary climate initiatives and regulatory pressure find that voluntary initiatives do not substitute but rather complement regulatory pressure. The negative relationship in the US between carbon intensity and Tobin's Q indicates that market valuations react to a rapid market driven price increase of fossil fuels. However, to rely on the market driven price path of fossil fuels to move towards a greener economy seems risky because the price increase during the period analyzed was somewhat exceptional. As long as the sum of extraction costs and scarcity rent of fossil fuels is not fully reflective of the costs caused by pollution and global warming and no cheap backstop technology is available, market forces create a socially suboptimal outcome. This creates the opportunity for Pareto improvements through voluntary action and voluntary initiatives. Yet the market logic inherently limits the effectiveness of these approaches. On the other hand, the efficacy of regulatory pressure is illustrated by the finding that markets are twice as sensitive in the valuation of corporate carbon intensity in the UK as compared to the US. The robustness checks for both countries are in line with the view that some underinvestment in green technologies might be an issue. Other potential explanations for the observed patterns are for instance changes in product portfolio or management.

The positive abnormal returns for members in the CCX when the Waxman-Markey Bill passed in the House of Representatives offers hints for the design of voluntary environmental initiatives. Namely, the design should fit well with the type of government intervention that is most likely. In that manner, VEP membership guarantees a head start if regulatory interventions are implemented. Moreover, we find no short-run market reaction for firms announcing CCX membership while Fisher-Vanden and Thorburn (2011) find a negative reaction for firms announcing CL membership. The comparison of these results to the market reactions when the Bill was passed indicates, that shareholders value membership in voluntary climate initiatives only in the light of regulatory pressure.

The two SRI portfolio analyses illustrate that investing with self imposed constraints does not necessarily imply subpar financial performance. Even though we find no risk adjusted abnormal returns for portfolios consisting of big firms, the financial performance of this portfolios is not negatively affected by the extensive use of negative industry screens. SRI characteristics are priced correctly for these big firms with wide analyst coverage. However, we find substantial positive abnormal returns for a portfolio of small growth firms with a focus on strategic CSR. This result also persists when in robustness checks the joint hypothesis problem is addressed. We argue that two different hypotheses might produce the observed result. Either valuable SRI characteristics of theses strategic CSR firms are not priced correctly or SRI affects the stock price of these firms. Because the portfolio consists of small and middle sized firms, both explanations seem plausible. Information on small firms is less readily available and to cover research costs is more difficult because the price reacts more elastic to demand shocks. Therefore, firm characteristics can potentially be incorrectly priced. But because SRI experienced high growth rates in the analyzed period, a demand shock might account for positive abnormal returns in the transition to a new equilibrium. Yet the available data and the results at hand do not allow to disentangle these two hypotheses.

Chapter 2

Corporate carbon intensity and firm valuation: The effect of regulatory pressure

Abstract

This paper investigates whether carbon intensity of firms is related to financial performance as measured by Tobins' Q. The carbon intensity of publicly listed firms is assessed at the overall firm level. I distinguish between two potential costs related to corporate carbon emissions, inherent and regulatory costs. While regulatory costs are related to regulatory interventions or risks related to future government interventions, inherent costs are driven by the development of input prices. The existence of these two sources of costs is addressed by means of a dynamic panel framework. I estimate firm valuation models for two regions with well developed stock markets that are distinct with respect to federal carbon emission policies, namely the United States and the United Kingdom. There is evidence for a negative relationship between carbon intensity and Tobin's Q in both markets, however twice as large in the United Kingdom. Put differently, an increase in carbon intensity has about twice the penalty in terms of Q in the United Kingdom and vice versa, a decrease twice the reward. The results highlight the role of regulatory

pressure for markets to reward climate friendly behavior and suggest that rapidly rising input prices, as observed during the period analyzed, help steer markets towards greener behavior.

2.1 Introduction

In 1986 the Environmental Protection Agency of the United States started a program with the intention of using information provision as a regulatory instrument. To this end, two years later the Toxic Release Inventory (TRI) was initiated. In 1992 the United Nations Conference on Environment and Development affirmed the right of communities to know about toxics, chemicals, and other substances. Currently more than 30 countries have adopted so-called pollutant release and transfer registers.[1] These registers ensure the measurement of plant emissions above a certain threshold. Emission measurement is a necessary condition for efficient emission management. But is the mere measurement and disclosure of emissions enough to incentivize firms to reduce emissions? A pecuniary incentive for active emission management would be given if it were an obviously a profitable strategy from the firm's perspective. However, whether unrealized profitable emission reductions exist due to investment-inefficiencies in green technologies actually exist is a controversial subject.

In the last decades voluntary efforts aiming at better corporate environmental performance, such as industry initiatives and shareholder activism, have gained popularity. Admittedly, the distinction between voluntary and coerced action is rather gradual than clear cut. The term voluntary is often used in the absence of intrusive government intervention, but often there is also disagreement about the intrusiveness of an action (Klein, 2007). In 1989 one of the first investor backed initiatives was launched to pressure corporations to endorse their code of corporate environmental conduct (Coalition

[1] http://www.prtr.net/en/links/, visited on February 10 2012

for Environmental Responsible Economies). Recently, some investors have been particularly concerned about the carbon emissions of big corporations. For instance, the Carbon Disclosure Project, an initiative of 543 investors with assets of USD 64 trillion, has urged companies to disclose their carbon emissions and their associated risks.[2]

This study investigates if an improvement in corporate carbon efficiency is valued by the stock market. More specifically, I analyze whether there is a link between corporate carbon intensity and Tobin's Q (Q). I opt for Q as the financial performance measure because it proxies for firm value, capturing future growth opportunities and indicating future profitability. In what follows, I differentiate between two types of costs: Regulatory and inherent. By assessing the relationship between corporate greenhouse gas (GHG) intensity and Q for firms based in the United Kingdom (UK) and the United States (US), this study sheds light on the role of the regulatory context. In the absence of taken, threatened, or imminent federal action by the regulatory authorities in the US, the expected inherent costs of carbon emissions are of crucial concern from a risk management perspective. With expected costs I mean the net present value of costs capturing current costs plus the future distribution of costs. In Section 2.3 I identify the market driven price path of fossil fuel energy sources (such as oil) as main origin of inherent costs. Because of existing federal legislation addressing carbon emissions and threatened further regulatory steps, expected regulatory costs of carbon emissions seem more relevant in the UK than in the US. It is not readily obvious, however, if a link between carbon intensity and Q exists and whether institutional differences affect this relationship. I argue that the role of regulatory pressure can be inferred by comparing the explanatory power of the carbon intensity variable in the valuation models for the UK and US market.

To this end, this study uses new carbon emission data on the global firm level of publicly listed companies from Trucost, a UK based data provider.

[2] https://www.cdproject.net/CDPResults/CDP-2010-G500.pdf, visited on November 18 2010

Whereas related eco-efficiency studies make inference from aggregated eco-performance of some plants and facilities of a firm on its overall financial performance, this study uses global firm level emissions in the inference. Accounting for global firm level emissions has recently only become feasible due to the development of a corporate GHG accounting and reporting standard issued in 2001 under the title "The Greenhouse Gas Protocol".

Existing studies have been focusing exclusively on local pollutants such as toxic emissions. This study adds corporate GHG intensity akin to Busch and Hoffmann (2011) to this strand of literature. As a novelty, I conduct a static and dynamic panel data analysis with environmental outcome data (Arellano and Bond, 1991; Baltagi, 2008). In addition, I compare two regions with a different policy approach to carbon emissions. Based on a short overview of the relevant eco-efficiency literature for this paper (Table A2.5), I argue that unobserved firm-heterogeneity is a principal concern. This claim is in line with King and Lenox (2001), Elsayed and Paton (2005), and Telle (2006). For the model specification, I derive the control variables and the dependent variable Q based on a brief literature survey (Table A2.6). The results highlight that some variable specifications might produce time-inconsistencies in the model estimations, potentially resulting in a look-ahead bias.

This study finds a negative link between the carbon intensity of a firm and Q. A decrease of carbon emission per value of output is associated with a significant increase in Q. Compared to the US, this relationship is about twice as large in the UK. This difference is likely attributable to substantially higher regulatory pressure in the UK. Still, the findings for the US suggest that even low regulatory pressure provides markets some incentives for higher carbon intensities.

The remainder of this article is organized as follows. Section 2.2 presents a short overview of the eco-efficiency literature. The relevant issues of this literature with respect to corporate carbon emissions are identified in Section 2.3. In section 2.4 I layout the model specification and describe the data. Based on a discussion of the empirical results in Section 2.5, Section 2.6 concludes.

2.2 Literature and theory

In a perfect market the environmental performance of a firm should not be related to its financial performance because each firm is investing in environmental technologies until marginal costs equal marginal benefits. Whether there exist investment-inefficiencies due to information asymmetries or high hurdle rates due to short sighted management is a controversial debate (e.g. Allcott and Greenstone, 2012; Nadel and Therese, 2012; Anderson and Newell, 2004; Howarth et al., 2000). However, in their survey on the long run economic impacts of voluntary environmental firm performance Blanco et al. (2009) conclude that being green relates neutrally or positively to financial performance. This suggests that over-investment in green technologies is absent and that improving eco-efficiency is not merely a cost factor but creates revenue increasing and cost decreasing opportunities. Ambec and Lanoie (2008) identify the following three revenue increasing opportunities: Better access to certain markets, differentiating products, and selling pollution control technologies. On the other hand, they identify four costs reducing opportunities: Risk management and relations with external stakeholders, cost of materials, energy and services, cost of capital and cost of labor. Russo and Fouts (1997) relate corporate environmental performance to the resource based view of the firm which stresses the importance of intangible resources[3] of firms as key to a competitive advantage (Villalonga, 2004). Other authors also see reputation as a driving force for good corporate behavior. But Karpoff et al. (2005) have shown that the short run stock market reaction to corporate environmental violations is largely explained by legal and regulatory penalties, leaving no explanatory power for reputational penalties.

Different methodological approaches have been taken in the empirical literature to show that eco-efficiency is not a mere cost factor. Event studies (see e.g. Hamilton, 1995; Konar and Cohen, 1997) have uncovered that publicly

[3]intangible assets such as corporate culture, brand name, reputation, particular technology, accumulated consumer informations.

published reports on the corporate environmental performance (CEP) affect short-term stock market prices of the respective companies. By assuming semi-strong market efficiency, meaning that all publicly available information is priced into stock prices (Fama, 1970), this illustrates that investors do react to new corporate environmental information. Another branch of the literature takes a portfolio approach and sorts firms based on some corporate environmental performance measure into eco-efficient and eco-inefficient portfolios. Derwall et al. (2005) for instance use environmental ratings from Innovest as a sorting variable and find positive abnormal returns for the more eco-efficient portfolio. But in their survey of portfolio studies (Ambec and Lanoie, 2008) find no clear evidence for abnormal returns.[4] A third strand of empirical approaches adopts the long term view by investigating in a micro econometric approach the relation between corporate environmental and financial performance such as Q, return on assets, return on sales or return on equity. The more recent of these studies are using a panel data, allowing to control for unobserved firm heterogeneity by using fixed firm effects (King and Lenox, 2001, 2002; Elsayed and Paton, 2005; Telle, 2006).

A brief overview of relevant eco-efficiency studies for this paper is presented in Table A2.5 in the appendix. Other detailed surveys on eco-efficiency and financial performance can be found in Ambec and Lanoie (2007) and Blanco et al. (2009). Table A2.5 illustrates that many studies make inference based on cross-sectional samples, neglecting unobserved firm heterogeneity (Hart, 1995; Russo and Fouts, 1997; Dowell et al., 2000; Konar and Cohen, 2001; Guenster et al., 2011; Busch and Hoffmann, 2011) . On the other hand King and Lenox (2001, 2002) and Telle (2006) account for fixed firm effects and Elsayed and Paton (2005) even exploit the dynamic panel structure of their data. The studies of King and Lenox (2001, 2002); Telle (2006); Konar

[4]The appeal of the portfolio approach is its robustness to outliers on the firm level but this comes at the cost of abnormal returns having an ambiguous interpretation. Without additional investigations only an error in expectations related to some firm characteristics is revealed but the driver of abnormal returns remains (often) unclear.

and Cohen (2001) use environmental outcome data derived from plant and facility level emissions and Busch and Hoffmann (2011) use as explanatory variables GHG emissions on the overall firm level. Generally, the use of environmental outcome data seems to be more meaningful than to rely on ratings or firm policies.

Only few eco-efficiency studies focus specifically on carbon emissions. To date two studies investigate if voluntary disclosed information on corporate carbon efficiency or management of companies has an impact on long run financial performance. Busch and Hoffmann (2011) investigate if corporate carbon intensity and carbon management are related to corporate financial performance (CFP). In a cross sectional analysis they find that Q is significantly negative related to the carbon intensity of a firm. Ziegler et al. (2011) find weak evidence that the stringency of institutional pressure might lead to higher stock performance of firms that assert to take climate change seriously when forming portfolios based on the level of disclosed responses to climate change. Similarly two event-studies look at the short run market reaction to corporate membership announcements in voluntary climate initiatives. While Fisher-Vanden and Thorburn (2011) find a negative market reaction for firms joining the government-partnership program Climate Leaders, Gans and Hintermann (2013) find a positive reaction for corporate membership announcement in the Chicago Climate Exchange in a difference-in-difference approach with monthly data. The later also find positive abnormal stock returns for their sample when proposed GHG legislation (Waxman-Markey bill) was passed on June 26, 2009, in the US House of Representatives. Mollet and Ilic (2013) apply a proper event study methodology for members in these two voluntary agreements and find no significant announcement returns for Chicago Climate Exchange membership. Investigating the market reaction to the Waxman-Markey event they find a positive abnormal returns for Chicago Climate Exchange members but not for Climate Leader members and relate this difference to program design.

2.3 Hypothesis and test strategy

Carbon-emissions are fundamentally different from toxic emissions: They are more diffuse and have a less immediate impact. Due to these characteristics lowering carbon emissions is a less likely candidate for labor cost savings because the proximity of employees and neighbors to the emission source is not putting their health at risk. Therefor litigation and legal costs have a lower occurrence probability unless carbon and toxic emissions are emitted jointly. The global impact of carbon emissions makes it more difficult for stakeholders to organize than in the case of local toxic emissions and therefore a coasian bargaining solutions is less likely due to high transaction costs (Coase, 1960).

Within Ambec and Lanoie's framework (2008) predominantly cost reducing opportunities arise with respect to corporate carbon-efficiency in the form of better risk management and enhanced relations with external stakeholders.[5] Substantial costs and downside risks in the area of risk management arise also out of current or uncertain future carbon emission regulation,[6] allowing companies with a carbon management system in place to develop better strategies in response to uncertainties about the future regulatory environment. Another downside risk independent of regulatory action consists of the uncertainty about the price path development of fossil fuels. Due to a combination of exhaustible supply and rising worldwide demand these prices tend to shift upward (Hotelling, 1931; Kilian, 2009). Over the period analyzed in this study for instance, the oil price tripled.[7] Because the UK and US

[5]Excluded in this analysis are the risks faced by corporations as constituted by shifting temperature and weather patterns and their physical (see IPCC, 2007) and macro economic (see Nordhaus, 2007; Stern, 2007)implications.

[6]Regulation could be directed towards pricing carbon emissions, increasing taxes on fossil fuels or using command and control instruments to impose minimal efficiency standards.

[7]From 2003 to 2008 the price for a barrel of oil rose according to the London Brent Crude Oil Index from around 30 USD to over 100. With the onset of the financial crisis the price crashed to 40 and rose again to over 90 USD at the end of 2010.

both depend on imported fossil fuels, they have roughly the same exposure to these uncertain net present value costs.

Different stakeholders are concerned with climate change and would like to see corporations address the issue by operating carbon efficiently and by innovating carbon efficient products. The Carbon Disclosure Project asks corporations to address carbon risks and to disclose carbon emissions. Several other investor backed initiatives such as the Investor Network on Climate Risk (INCR) supported by Ceres and also institutions of the United Nations[8] show substantial interest in corporate emissions. This wide investor base concerned with corporate carbon emissions and the related expected costs, caused by current or potential future costs, tries to exert pressure on companies.

In this paper I postulate that carbon emitters are faced with two factors affecting expected costs: The inherent and the regulatory current and future costs. The expected inherent costs of carbon emissions are not related to regulation. If these expected costs were of sufficient magnitude, market forces are capable of moving corporations towards more carbon-efficiency. The expected regulatory costs on the other hand arise from current regulation or threatened future regulatory action aiming at making carbon-emissions directly or indirectly more expensive. In this study I refer to these governmental actions also as regulatory pressure.

I evaluate the effect of carbon-efficiency on Q in two different regulatory regimes by estimating a model with the forward looking financial performance measure Q separately for the US and the UK market. In contrast to Ziegler et al. (2011) I look at effective carbon emissions and I do not analyze the entire region covered by the mandatory European Union Emission Trading System (EU ETS) but focus on the UK market. This focus reduces sample size but has two advantages: Looking at a the biggest homogenous European stock market and not having to worry about currency conversion. The UK is a member state in the EU ETS, workable since 2005, and also created in

[8] http://www.unepfi.org/fileadmin/documents/global_framework.pdf, visited on July 6 2011

2002 already the voluntary "UK Emission Trading Syste". Carbon emissions in the UK are therefore priced and the EU has signaled that also in the future carbon emissions will be priced. Almer and Winkler (2012) even find only for the UK an emission reduction effect among the Kyoto signatories. The USA on the other hand have very high per capita carbon emissions and never signed the Kyoto protocol. There are currently no federal standards, taxes or other regulation that put a price on carbon emissions in the US. However, regional and local initiatives do exist.[9] The US have always been very active in promoting voluntary initiatives (e.g. Lyon and Maxwell, 2003). Böhringer and Vogt (2004) illustrate that the EU was taking the adaptation of a climate change policy more seriously than the US and attribute the unwillingness of the US government to aim for substantial and binding emission reductions in a political economy approach to the attitude of the median US voter. For this voter climate change was of low priority from the 90's to the new millennium and his willingness to pay eco-taxes was low. More recent Gallup pools, the Eurobarometer and the World Value Surveys indicate that European citizens are generally more concerned with climate change than American citizens (Ziegler et al., 2011). Also the management of a firm and potential investors are affected by these differences in politics and general attitudes. The environmental management practices and purchasing decisions of environmental technology is generally determined by the headquarters of a firm (Cole et al., 2013). The headquarters opinions and assessments hence have consequences for the entire firm. The pressure exerted by investors on companies also varies due to investors home bias (French and Poterba, 1991; Karolyi and Stulz, 2003).

Gans and Hintermann (2013) and Mollet and Ilic (2013) find evidence that the unexpected passing of the Waxman-Markey bill, suddenly raising the likelihood of federal legislation targeting carbon emissions, produces positive abnormal returns for firms with a membership in the Chicago Climate

[9]Examples are

Exchange. Similarly Kim and Lyon (2011) find abnormal returns for members in the Carbon Disclosure Project upon the sudden Russian ratification of the Kyoto-Protocol. Studies covering the EU ETS area such as Veith et al. (2009), Oberndorfer (2009), Bushnell et al. (2011) and Schmidt and Werner (2012) present evidence that the price of carbon permits does affect stock market performance. This illustrates that substantial expected regulatory costs might indeed exist for carbon emissions. As discussed, eco-efficiency studies find a positive or no relation between environmental and financial performance. Therefore I expect generally a negative or neutral relationship between corporate carbon intensity and financial performance. Because the expected regulatory costs are more tangible in the UK than the US, the relationship should be more pronounced in the UK, say more negative, than in the US.

2.4 Model and data

The unbalanced firm panels with annual data begins in 2003. Because of the onset of the financial crisis in 2008 I restrict the analyzed time period from 2003 to 2007. In all scenarios analyzed I find clear evidence for firm fixed-effects. Due to autocorrelation in the residuals for fixed-firm effect models, the following model specification is preferred:

$$\begin{aligned} Q_{it} &= \alpha Q_{it-1} + \beta^{'} CI_{it-1} + \gamma^{'} \mathbf{X}_{it} + \epsilon_{it} \\ \epsilon_{it} &= \mu_i + \theta_t + \eta_{it} \end{aligned} \tag{2.1}$$

In equation 2.1 Tobin's Q is explained by a lag of the dependent variable Q, a vector of control variables X_{it} and the lagged carbon intensity variable CI_{it-1}. CI is lagged by one year because it takes longer for environmental information to become public information than for the well established financial reporting measures. Lagging a firms carbon-intensity should also help to

address simultaneity and reverse causality problems. The financial data used in **X** and Q are from Thomson Reuters Datastream. As left hand side (LHS) variable I opt for Q because it is in contrast to criticized accounting based performance measures a forward looking measure (McFarland, 1987) based on the expectations of investors. Tobin (1969) proposed Q as performance measure defined as the market valuation of a firm in relation to the replacement value of its tangible assets. The total market value of a firm equals the sum of the tangible and the intangible assets of a firm, hence $V_T + V_{IT} = TMV$. Q is obtained by dividing MV with the tangible asset value V_T which leaves us with $Q = 1 + V_{IT}/V_T$. Different approximations for Q exist in the literature (e.g. Lindenberg and Ross, 1981; Chung and Pruitt, 1994). Perfect and Wiles (1994) empirically evaluate five alternative estimators of Q and find that when changes in Q are used for regression purposes no significant differences are revealed among the different measures. Due to the use of a fixed effect estimator, captured by μ_i in the decomposition of the error term ϵ, I opt for a relatively simple calculation of Q. Table A2.6 illustrates how Q is calculated in studies with Q as the right hand variable (RHS). Following Guenster et al. (2011); Bebchuk et al. (2008) I opt for calculation of Q as shown in equation 2.2.

$$Q = \frac{MVCS + (TA - EQ - BSDT)}{TA} \tag{2.2}$$

The market value of common stock (MVCS) is added to the book value of a firms total assets (TA) and the sum of book value of common stock (EQ) and balance sheet deferred taxes (BSDT) is subtracted. This approximation of TMV is divided by the book value of total assets. Using $MVCS$ instead of the market value of equity $MVEQ$ as declared in the annual report has the advantage of being available continuously through time and not only once a year. The book values used in equation 2.2 and in 2.1 are made public only at the end of the fiscal year. But the month of the fiscal year end varies across companies and countries. The default role for year assignment based

on the fiscal year varies in Thomson Reuters Datastream across countries. Furthermore, if the fiscal year is at the beginning of the calendar year $\tau + 1$, the market capitalization $MVEQ$ is taken at the end of calendar year τ. This results in time inconsistencies in the estimation of 2.1 resulting potentially in a look-ahead bias. Therefore I prefer to use MVCS in equation 2.2 over using MVEQ. I assign year τ to fiscal years from January 21 τ until January 20 of year $\tau + 1$. The market value of common equity $MVCS$ is always extracted at the end of June and following Fama and French (1992) I assume that it takes at least 3 month for the public information of the annual report to be priced in.

Following King and Lenox (2001) I control in equation 2.1 for firm size by taking the logarithm of total assets, and control for capital intensity (capint), leverage two year salesgrowth average (salesgra) and research and development (R&D) expenditures scaled by sales (rdint). As Durnev and Kim (2005) I set R&D expenditures to zero if they are missing in Thomson Reuters Datastream. Table 2.1 shows that all variables measuring an intensity are either scaled by sales or total assets. In accordance with prior Q regressions (Ammann et al., 2011; Aggarwal et al., 2009) I also include in the estimation cash intensity (cashint), property-plants and equipment intensity (ppe),earnings before interest and taxes to sales (ebit), American Depositary Receipt (ADR) dummy and the percentage share of closely held shares(closely_held). In line with Bebchuk et al. (2008) and Guenster et al. (2011) firm age approximated by the firms incorporation year. Following (Dowell et al., 2000) the percentage share of foreign sales is also a control variable (foreign_sales). In the eco-efficiency studies using fixed effects only Elsayed and Paton (2005) use advertisement expenditures as a control variable. Because information on advertisement is scarce, Elsayed and Paton (2005) proxy advertisement with intangible assets. I intentionally do not follow this approach, because the intangible assets V_{IT} are exactly the part of Q I intent to explain (Angrist and Pischke, 2008). Moreover, I do not include return on assets (ROA) as a control variable becuase it is highly correlated with ebit. Konar and Cohen

(2001) are the only ones to include market shares and industry concentration in their cross-sectional estimations. Assuming that these datapoints do not change over the period considered, I do not include them. The firms with the industry classification "Financials" are dropped from the dataset because of their distinct business model relying on excessive use of leverage. This industry is obviously also not relevant when looking at GHG emissions. Additionally, only companies are included that report their financial data in local currencies. Therefore the financial data are denominated for the UK sample in pounds and for the US sample in US dollars. But the currency denomination remains only relevant for the carbon intensity and the size variable. To address the problem of outliers and influential observations I winsorize the variables Q, ebit and salesgra at the 2% and 98% percentiles.

Table 2.1: Variable overview

	Variable list	Description	Main Worldscope mnemonic
Q	Qmv	$\frac{MVCS+(TA-CS-BSDT)}{TA}^{\star}$	$\frac{MV+WC02999-WC03501-WC03263}{WC02999}$
CI	laglogemi	log(lagged carbon emission intensity)	$\frac{scope1}{WC01001}$
	size	log(total assets)	WC02999
	capint	capital expenditures / total sales	WC04601
	leverage	total dept / total assets	WC03255
	salesgra	sales growth average over last 2 years	WC01001
	rdint	R&D-expenses / sales	WC01201
	cashint	cash / total assets	WC02001
X	ppe	property-plants-equipment / sales	WC02501
	ebit	ebit / sales	WC18191
	foreign_sales	international sales / total sales	WC08731
	closely_held	percentage closely held shares	WC08021
	age	company age based on incorporation year	WC18273
	adr	ADR indicator	WC11496

* MV: Market value, BV: Book value, BSDT: Balance sheet deferred taxes, MVCS: Market value of common stocks

The carbon emission data are taken from the database Trucost and cover-

age begins in the year 2002. This is an UK based environmental data provider that collects a plethora of corporate environmental data and also estimates datapoints based on an detailed input output model. Trucost applies a single methodology to derive emission estimates, takes advise from an academic panel and always contacts companies for feedback on the compiled data. Following the methodology described in the "Greenhouse Gas Protocol" (GHG Protocol), Trucost converts the six Kyoto gases[10]into GHG equivalents using conversion factors. The GHG-Protocol was developed in 2001 by the World Resource Institute (WRI) and the World Bussines Council for Sustainable Development (WBCD). It constitutes a standard[11] for companies on how to calculate and report their carbon emissions in three categories: Scope 1 covers the direct emissions occurring from sources that are owned or controlled by the company, scope 2 captures the indirect carbon emissions consisting mainly of the purchase of electricity, and scope 3 covers other indirect GHG emissions such as the emissions from the supply chain and the use of sold products and services. A more detailed description of the different scope categories can be found in WBCD and WRI (2004) or in Table 1 of Hoffmann and Busch 2008. I use scope 1 emissions and scale these direct emissions by sales. I prefer to use this corporate carbon footprint only if datapoints are not purely derived by Trucost's estimation procedure but contain some additional information. The information may come from environmental reports, corporate social responsibility reports, from the carbon disclosure project or may also be derived from fuel consumption data or from data received in personal communication with the firms . I require some additional information for the sample firms because the specification of Trucost's input-output model is unknown. Additionally, the within firm carbon-intensity changes are much lower for firms disclosing some information as compared to firms with

[10]carbon dioxide, methane, nitrous oxide, sulphur hexafluoride, hydrofluorocarbons and perfluorocarbons

[11]The "Carbon Disclosure Project" is referring to the GHG protocol and ISO 14064-1 as the global standards

a change in the disclosure regime. As denominator for scaling the emission data to carbon-intensity measures I use sales. Therefore, this study looks at direct firm emissions from production and operations in relation to sales. The resulting carbon intensity is determined by the industry or industries of operation of a firm and by company-specific factors such as product portfolio, environmental management and technological equipment. The studies of King and Lenox (2001) and Telle (2006) rate facilities relative to their peers and the industry they operate in. Due to the problem of benchmark identification when looking at emissions at the overall firm level, a firm can operate in different industries simultaneously and the higher aggregation produces less observations, this study focuses on carbon-intensity changes within the firm.

2.5 Empirical results

2.5.1 Descriptive statistics

The unbalanced panel data used to estimate equation 2.1 cover the period from 2003 to 2007. Table A2.7 shows how the number of firms in the two country samples evolve. For each sample firm the explained and all explanatory variables as listed in Table 2.1 must be non-missing. Different sectors are not equally represented in the two samples as illustrated in Table A2.8. According to the Industry Classification Benchmark (ICB), industrials have with 28% the highest share in the UK sample while the highest share is held in the US sample by utilities with 30% . As mentioned, the month of the fiscal year differs across firms and countries. In the UK sample approximately 60% of the firm observations have the fiscal year in December and in the US data this respective share is 80%.

Table A2.9 and A2.10 show pooled firm-years summary statistics for the UK and the US sample. Comparing the two samples we find that the logarithmized Q (logQmv) is slightly higher in the UK and in both countries

sales are growing by 10% on average. On average lower in the UK are the logarithmized emission intensity (laglogemi), firm size, property-plants and equipment intensity and the logarithm of the approximated company age. Some of these differences might be due to not identical sector representation in the two samples. The percentage of closely held shares is higher for the UK sample and almost half of the UK firm-year observations are cross-listed in the US with an ADR (indicator_adr). The pairwise correlations for the two samples in Table A2.11 paint a consistent picture. All financial variables have the same expected correlation with the dependent variable logQmv. The only exception is capint with a positive correlation in the UK and a slightly negative one in the US. A different relationship can also be found in the logarithmized firm age which is virtually zero in the UK and positive in the US. The lag of the logarithmized carbon intensity laglogemi correlates in both countries negatively with the performance measure logQmv, but this relationship is more than three times stronger in the US. The pairwise correlations depict that higher carbon intensity is associated with lower values of Tobin's Q for both samples. But these correlations also establish a much stronger negative association in the US.

2.5.2 Regression results

I begin the analysis by exploring if a random effects (RE) or fixed effects (FE) model fits better the firm samples without considering the dynamic structer (laglogemi) yeat. The reported FE and RE models in Table 2.2 include both year and and sector dummies. Because sector affiliation and the ADR dummy variable (indicator_adr) are fixed characteristics over time, these variables disappear with the within transformation of a FE model. All test statistics clearly indicate for both country samples that unobserved firm heterogeneity is important. This suggests to use a FE model. The F test that all firm specific effects are zero in the FE model is overwhelmingly rejected. The Hausman test (Hausman, 1978) and also the Breusch and Pagan Lagrangian

multiplier test for random effects are unambiguously rejected. Moreover, Guggenberger (2010) shows that due to power distortions of the Hausman test it is always more conservative to estimate a FE model. Therefore, I clearly favor the FE model. The FE point estimates in Table 2.2 for the lagged emission-intensity variable are in both samples significantly negative. But the observed negative effect is about twice as large in the UK as in the US. Also the RE estimation results show a significantly negative laglogemi coefficient for the UK sample. The null hypothesis of the Wooldridge test for no first-order serial autocorrelation in panel-data models (Wooldridge, 2002) is overwhelmingly rejected for both panels and also for all other scenarios tried as robustness checks.[12]

This results suggests to use a lagged dependent variable on the right hand side. I proceed by estimating a fixed effects model with the lagged Q variable as explanatory variable as noted in equation 2.1. The presence of a lagged dependent variable induces a bias in pooled OLS as well as in within group estimations (see e.g. Bond, 2002). The FE estimation of equation 2.1 triggers the Nickell (1981) bias. However, if all control variables in $\mathbf{X}$ are strictly exogenous, only the lagged dependent variable is affected by this bias. Generally, consistent estimates can be retrieved using GMM. Arellano and Bond (1991) have proposed within that framework to use a full set of valid lags as instruments. This method requires $T > 3$ and therefore reduces the unbalanced firm panels somewhat.

Table 2.3 and 2.4 present different dynamic panel estimation results for the UK and the US market. Differently estimated dynamic panel models as specified in equation 2.1, accounting for fixed firm effects and a lagged dependent variable, are shown in the four columns. The first two columns are fixed effects estimators, extending the fixed effect estimator of Table 2.2 by including the lagged dependent variable as explanatory variable. Compared to column (1), column (2) uses a FE estimator with intra-firm clustered standard

[12] As a cross check I Iooked at longer time series, different time periods and samples and found this test usually rejected.

Table 2.2: Random- & fixed effects for UK and USA

	UK		*USA*	
	Random effects	Fixed effects	Random effects	Fixed effects
laglogemi	−0.054 ∗ ∗	−0.126 ∗ ∗	−0.022	−0.065 ∗ ∗
	[−3.11]	[−4.62]	[−1.38]	[−2.64]
size	−0.059 ∗ ∗	−0.195 ∗ ∗	−0.107 ∗ ∗	−0.459 ∗ ∗
	[−2.12]	[−2.80]	[−5.36]	[−8.51]
capint	1.380 ∗ ∗	0.702	1.640 ∗ ∗	0.877 ∗ ∗
	[2.25]	[0.98]	[3.68]	[2.01]
leverage	−0.254∗	−0.351∗	−0.445 ∗ ∗	−0.437 ∗ ∗
	[−1.71]	[−1.83]	[−3.15]	[−2.66]
salesgra	−0.001	−0.001	0.000	0.001
	[−0.61]	[−0.43]	[0.23]	[1.17]
rdint	−0.342	−1.529	0.158	−0.659
	[−0.57]	[−1.06]	[0.24]	[−0.62]
cashint	0.104	0.092	0.575 ∗ ∗	0.555 ∗ ∗
	[0.49]	[0.41]	[3.30]	[3.07]
ppe	−0.142 ∗ ∗	−0.245 ∗ ∗	−0.115 ∗ ∗	−0.052
	[−2.97]	[−3.18]	[−2.67]	[−0.82]
ebit	0.625 ∗ ∗	−0.043	0.837 ∗ ∗	0.389 ∗ ∗
	[3.06]	[−0.18]	[5.68]	[2.63]
foreign_sales	0.001	0.003 ∗ ∗	0.002 ∗ ∗	−0.000
	[1.28]	[2.69]	[2.37]	[−0.21]
closely_held	−0.001	−0.002∗	0.000	0.000
	[−1.04]	[−1.75]	[0.05]	[0.04]
logage	−0.019		0.061 ∗ ∗	
	[−0.63]		[2.45]	
indicator_adr	0.082			
	[0.86]			
constant	1.317 ∗ ∗	3.189 ∗ ∗	1.941 ∗ ∗	8.066 ∗ ∗
	[3.17]	[3.19]	[5.59]	[9.02]
year dummies	*Yes*	*Yes*	*Yes*	*Yes*
Sector dummies	*Yes*	*No*	*Yes*	*No*
Observations	302	302	416	422
Nr. of firms	106	106	147	148

t statistics shown in brackets. Significance levels: * p< 0.10, ** p< 0.05, *** p< 0.01.

The Breusch-Pagan lagrangian multiplier test for random effects is clearly rejected. The rejection of both the F test that all firm specific effects are zero and of the Hausman test indicate that a fixed effects model should be favored. In the fixed firm effect model however, the Wooldridge-Drukker test for no first-order autocorrelation is clearly rejected.

errors. These two estimators are considered because the Arellano and Bond (1991) GMM estimator is asymptotic efficient on N but the analyzed samples are finite. The robust Arellano-Bond one step estimator is shown in column (3) and the two step estimators corrected for Windmeijer's (2005) sample correction in column (4). For both FE estimators in column (1) and (2), the coefficient of the lagged Q is high and significant in the UK and the US. In these estimations also the coefficient of laglogemi, the variable measuring the emission intensity, remains for both country samples negative and significant at the 1% level. But the negative effect in the UK has almost twice the magnitude than in the US. While the coefficient $\beta_{CI_{it-1}}$ is -0.11 in the UK, $\beta_{CI_{it-1}}$=-0.062 holds for the US. Columns (3) and (4) of Table 2.3 and 2.4 show the results of GMM estimations. For the assumptions in equation 2.1 to perfectly hold, we should observe first order autocorrelation AR(1) but no second order autocorrelation AR(2) after having transformed the data by first-difference. Moreover, the Sargan test with the null hypothesis of valid moment conditions has to be considered. Across the estimations, the pair of AR tests with the null hypothesis of no autocorrelation, is only for the one-step US estimation ideal with rejection for AR(1) and non-rejection for AR(2). But only in this unique estimation the Sargan test is rejected. This indicated either that the instruments are not orthogonal to the error term, or the test based on asymptotic properties is not be well specified for the analyzed finite samples.

Across all other GMM estimations, the hypothesis of no AR(1) process can not be rejected at conventional significance levels and the absence of an AR(2) process is never rejected wither. With these caveats in mind, it is nevertheless assuring that the coefficient of the carbon intensity variable varies only little across the 4 dynamic estimations from Table 2.3 and 2.4 . The results are even in line with the static fixed effect estimation of Table 2.2. Therefore, the results across the different estimation methods provide evidence for the conclusion that a reduction in corporate carbon-intesitity is associated with an increase in Tobin's Q. This relationship is about twice as

Table 2.3: Dynamic estimations, UK

	(1) Fixed effects	(2) Fixed effects, clustered by firm	(3) Arellano Bond, one-step	(4) Arellano Bond, two-step
L.logQmv	0.267 * **	0.267 * **	0.203	0.122
	[4.11]	[4.54]	[1.50]	[0.70]
laglogemi	−0.114 * **	−0.114 * **	−0.110 * **	−0.087 * **
	[−4.31]	[−4.15]	[−4.30]	[−3.37]
size	−0.168 * *	−0.168*	−0.356 * **	−0.397 * **
	[−2.51]	[−1.98]	[−3.63]	[−3.72]
capint	1.117	1.117	0.201	−0.278
	[1.60]	[1.33]	[0.23]	[−0.31]
leverage	−0.321*	−0.321*	−0.117	0.000
	[−1.74]	[−1.76]	[−0.76]	[0.00]
salesgra	−0.002	−0.002	−0.002*	−0.001
	[−1.35]	[−1.44]	[−1.71]	[−0.62]
rdint	−2.938*	−2.938 * **	−3.681 * *	−2.694
	[−1.94]	[−2.81]	[−2.44]	[−1.62]
cashint	−0.078	−0.078	−0.081	−0.072
	[−0.36]	[−0.30]	[−0.36]	[−0.31]
ppe	−0.313 * **	−0.313 * **	−0.298 * **	−0.235 * *
	[−4.14]	[−5.34]	[−3.31]	[−2.12]
ebit	−0.183	−0.183	−0.515*	−0.447
	[−0.77]	[−0.71]	[−1.91]	[−1.29]
foreign_sales	0.003 * **	0.003*	0.003 * *	0.003
	[2.80]	[1.92]	[2.13]	[1.47]
closely_held	−0.001	−0.001	−0.002*	−0.002
	[−1.22]	[−1.32]	[−1.68]	[−1.54]
constant	2.699 * **	2.699 * *	5.656 * **	6.258 * **
	[2.79]	[2.16]	[4.08]	[4.16]
year dummies	*Yes*	*Yes*	*Yes*	*Yes*
Observations	300	300	189	189
Nr. of firms	106	106	76	76
Nr. of instruments			26	26
AR1 test p-value			0.27	0.50
AR2 test p-value			0.702	0.433
Sargan test p-value			0.242	0.544

t statistics shown in brackets. Significance levels: * p< 0.10, ** p< 0.05, *** p< 0.01.
The columns (1) to (6) show the results of different dynamic panel models with a lagged dependent variable as explanatory variable. In (1) and (2) show fixed effects results with clustered standard errors by firm in (2). The robust Arellano-Bond one and two step estimators are presented in columns (3) and (4).

Table 2.4: Dynamic estimations, USA

	(1) Fixed effects	(2) Fixed effects, clustered by firm	(3) Arellano Bond, one-step	(4) Arellano Bond, two-step
L.logQmv	0.335 * **	0.335 * **	0.047	−0.187
	[5.82]	[4.73]	[0.32]	[−1.14]
laglogemi	−0.063 * **	−0.063 * **	−0.058 * *	−0.060 * *
	[−2.73]	[−3.02]	[−2.54]	[−2.09]
size	−0.391 * **	−0.391 * **	−0.471 * **	−0.520 * **
	[−7.42]	[−4.76]	[−4.48]	[−4.36]
capint	0.812*	0.812*	0.551	0.612
	[1.95]	[1.67]	[1.06]	[0.89]
leverage	−0.365 * *	−0.365	−0.173	0.057
	[−2.31]	[−1.61]	[−0.74]	[0.22]
salesgra	−0.000	−0.000	−0.000	−0.000
	[−0.11]	[−0.12]	[−0.32]	[−0.06]
rdint	0.670	0.670	0.098	−0.381
	[0.65]	[0.63]	[0.07]	[−0.17]
cashint	0.514 * **	0.514 * *	0.271	0.426
	[2.98]	[2.19]	[1.04]	[0.98]
ppe	−0.028	−0.028	−0.083	−0.097
	[−0.45]	[−0.33]	[−1.12]	[−1.16]
ebit	0.210	0.210	0.297	0.353
	[1.46]	[1.02]	[1.53]	[1.57]
foreign_sales	0.000	0.000	−0.001	−0.003
	[0.36]	[0.30]	[−0.48]	[−1.12]
closely_held	−0.000	−0.000	0.000	0.000
	[−0.07]	[−0.08]	[0.18]	[0.21]
constant	6.720 * **	6.720 * **	8.220 * **	9.133 * **
	[7.62]	[4.94]	[4.87]	[4.70]
year dummies	*Yes*	*Yes*	*Yes*	*Yes*
Observations	417	417	262	262
Nr. of firms	148	148	108	108
Nr. of instruments			26	26
AR1 test p-value			0.12	0.80
AR2 test p-value			0.575	0.917
Sargan test p-value			0.014	0.033

t statistics shown in brackets. Significance levels: * p< 0.10, ** p< 0.05, *** p< 0.01.

The columns (1) to (6) show the results of different dynamic panel models with a lagged dependent variable as explanatory variable. In (1) and (2) show fixed effects results with clustered standard errors by firm in (2). The robust Arellano-Bond one and two step estimators are presented in columns (3) and (4).

large in the UK as compared to the US.

In the following I illustrate that the results are not a mere artifact of the chosen specification and data selection. To start with, the same result are obtained if the financial data are not at all winsorized as described in Section 2.4. Some of the authors discussed in Table A2.5 limit their analysis to certain sectors. Hart (1995) drops the Standard Industry Classification (SIC) codes above 5000 in order to focus on firms in manufacturing, mining or with production of some kind. Russo and Fouts (1997) drop utilities arguing that their returns are subject to statutory limits.

Regression Tables A2.12 and A2.13 demonstrate the results obtained when I limit the analysis to four digit SIC codes bellow 5000 and additionally delete observations with SICs between 4931- 4999, the energy utilities (Busch and Hoffmann, 2011). With this sector selection the coefficients of laglogemi are slightly reduced and the significance level drops marginally in the US sample. Alternatively, I dropped observation with two digit SIC code 49 (Electric, Gas and Sanitary Services) instead of the four digit SIC codes between 4931- 4999. The results virtually remain unchanged. As explained in section 2.4, the presented results are based on samples with not purely estimated emission data. One might worry that this induces some kind of endogeneity because only firms are considered that communicate some kind of emission information. I prefer this data restriction because firm's carbon-intensities jump sometimes substantially when they reveal for the first time some GHG related information. In an attempt to use all available emission data in Trucost's database, including pure estimates, I address this outlier issue by winsorizing the 2% and 98% percentiles of the first-differenced carbon-intensities. The estimated dynamic panel results support the conclusion, that the negative relationship between carbon intensity and Q is substantially more pronounced and robust for the UK.[13] Additionally, I analyze whether the mere disclosure of corporate emission information results in a higher firm valuation. But the coefficient

[13]These results available from the author upon request.

of the dummy variable for information disclosure of public information (this excludes personal communication) is never significant.

Overall, the results provide evidence that firms managing to lower their carbon-intensities experience an increase in Q. This rise in Q can be interpreted as better future growth opportunities. The pairwise correlations in Table A2.11 grossly overstate the magnitude of the negative relationship in light of the results from Table 2.3 and 2.4. These results suggest, that lowering emission-intensity by 1% is associated with and increase in Q of about 0.11% in the UK and of approximately 0.06% in the US.

2.6 Conclusion

This paper assesses the relationship between corporate GHG-intensity and a firm's valuation as measured by Q. I motivate this relationship by making the distinction between inherent and regulatory expected costs for carbon emitters. Based on the literature discussion I identify revenue increasing and cost decreasing factors that apply to carbon emissions. I identify cost reducing opportunities related to risk management as the main upside opportunity. The empirical results of this study provide evidence for a negative relationship between carbon intensity and Q in the UK and the US. I do not claim that regulatory pressure is completely neglectable in the US during the analyzed time period from 2003 to 2007. For this reason, the negative effect in the US should not exclusively be attributed to expected inherent costs. Nevertheless, it is somewhat promising that lower carbon intensities are associated with better future prospects in the US market. The tripling of the crude oil price during the analyzed period might have contributed substantially to this result.

The difference in the relationship between the US and UK market illustrates the role of regulatory pressure, for expected inherent costs are roughly equal in both countries. The negative link between corporate GHG-intensity and Q is about twice as large in the UK as in the US, so it is fair to assume that expected regulatory costs weigh heavier in the UK.

My findings are in line with the view that some under-investing in green technologies are might be present. In Section 2.1 I argue that due to asymmetric information, over-investing in green-technologies is less likely to occur systematically compared to optimal investing or under-investing. Firms evaluating investment opportunities mainly consider the potential financial benefit. But in imperfect markets, not all investment opportunities might be on the radar. In turn, not all investment opportunities are evaluated. There is, however, a caveat to this finding. Firms self-select into the analyzed samples because they have to communicate some emission relevant information. Because various types of disclosures are taken into account, this self-selection issue is attenuated somewhat. By the same token, similar relationships between carbon intensity and Q are obtained if also purely estimated emission data are used.

I use fixed effects and GMM to analyze the link between carbon intensity and Q but refrain from any unambiguous causality claims. Still, the evidence is consistent with the view that lowering corporate carbon intensity brings about higher firm valuation. Further research could address the driving forces for changes in carbon intensities. Promising candidates seem investments in green technologies, management and environmental management practices, or changes in product-portfolio. These factors are likely to play a central role within the new strand of literature on the role of management practices for productivity and Q (Bloom and Van Reenen, 2007; Bloom and Reenen, 2010).

2.7 Tables

Table A2.5: Literature overview on eco-efficiency

Publication & journal	Short summary	LHS*	Main RHS
Busch and Hoffmann (2011) *Business and Society*	investigate whether corporate carbon intensity and management are linked to the financial performance of a firm. They find for a worldwide cross-sectional sample with data obtained through questionnaire in 2006 for 174 firms that lower carbon intensity pays off whereas only management measures have a detrimental effect for financial performance.	Q, ROA, ROE	GHG scope1 and 2 emissions according to the GHG protocol divided by sales in USD.
Guenster et al. (2011) *European Financial Management*	analyze with Innovest data for an US sample the link between eco-efficiency and financial performance between 1997 and 2004 based on quarterly data. They find with Fama-McBeth like cross sectional regressions that the market values environmental performance and that the valuation differential increased over time.	Q_{ia}, ROA_{ia}	Eco-efficiency score from Innovest Strategic Value Advisors
Telle (2006) *Environmental and Resource Economics*	finds in a pooled regression with Norwegian plant level data (with four manufacturing industries) between 1990 and 2001 a positive relationship between environmental and economic performance. But this effect is generally no longer significant when plant fixed-effects are taken into account.	ROS	Relative and industry environmental performance measures constructed with data from the Norwegian Pollution Control Authority (NPCA)
Elsayed and Paton (2005) *Structural Change and Economic Dynamics*	look at the relationship between environmental and financial performance for an UK firm panel containing 227 firms from 1994 to 2000. They find a neutral relationship when controlling for unobserved heterogeneity (fixed effects) and dynamic effects. The authors argue that many studies suffer from misspecification.	Q, ROA, ROS	Community and environmental responsibility scores of the Management Today Survey of Britain's Most Admired Companies (BMAC)
King and Lenox (2002) *Management Science*	find that waste prevention leads to financial gains in a panel of US firms from 1991 to 1996 when applying firm fixed or random- effects. But firms do not profit from other forms of reducing pollution. The authors argue that waste prevention is underexploited and often provides unexpected innovation offsets.	Q, ROA	Construct with Toxic Release Inventory (TRI) data: total emissions, waste generation, waste prevention, waste prevention, waste transfer.
King and Lenox (2001) *Journal of Industrial Ecology*	find for US manufacturing firms from 1987 to 1996 evidence for an association between lower pollution and higher financial valuation. But conclude based on firm fixed-effects results, that firm's fixed characteristics and strategic position might cause this association.	Q	Construct with Toxic Release Inventory (TRI) data: total emissions, relative emissions, industry emissions
Konar and Cohen (2001) *The Review of Economics and Statistics*	investigate for a cross-section of S&P500 firms in 1989 if environmental performance affects market value. Find a significant positive relationship between environmental performance and the intangible asset value of a firm.	Q	Toxic chemicals (from TRI) emitted per dollar revenue and the number of environmental law suits pending.
Dowell et al. (2000) *Management Science*	investigate the relationship between firm environmental standards and market value of multi national enterprises using pooled and random-effects regressions. Find for their S&P 500 sample from 1994 to 1997 that a stringent global environmental standard is related to a higher firm value.	Q, ROA, ROS	Environmental standard (local, US, stringent global) from Investor Responsibility Research Center's (IRRC) Corporate Environmental Profile.
Russo and Fouts (1997) *Academy of Management*	investigate the relationship between an environmental rating and ROA for 2 cross-sections of 243 firms for the years 1991 and 1992. Conclude that it pays to be green and that the relationship strengthens with industry growth.	ROA	Environmental ratings from the Franklin Research and Development Corporation
Hart (1995) *Business Strategy and the Environment*	investigate cross-sectionally whether a percentage change in emission reduction from 1988 to 1989 has an impact on economic performance. Find for a sample of 127 manufacturing and mining firms of the S&P 500 a positive relationship within 1 to 2 years.	ROS, ROE, ROA	Environmental performance and emission reduction measures from Investor Responsibility Research Center's (IRRC) Corporate Environmental Profile.

* Q: Tobin's Q, ROA: Return on assets, Q_{ia}/ROA_{ia}: Industry adjusted Q/ROA, ROS: Return on sales

Table A2.6: Literature on Tobin's Q, including 2 governance studies

Publication & journal	LHS*	RHS	Method	Industry analyzed	Q calculation*
Ammann et al. (2011) *Journal of Empirical Finance*	Q	governance indices, total assets, sales growth, R&D intensity, cash intensity, capital intensity, property-plant-equipment intensity, ebit on sales, leverage, adr dummy, closely held in %	firm, country and industry fixed-effects models, also using GMM	all	$\frac{MVEQ+(TA-EQ)}{TA}$ [1]
Bebchuk et al. (2008) *Review of Financial Studies*	Q_{ia}, α	governance index, total assets, ROA, capital expenditure on assets, R&D expenditures, leverage, industry dummies, approximated firm age, dummy for delaware incorporated, inside ownership	pooled- and fixed firm effects regressions	all, robustness check without financial firms	$\frac{MVCS+(TA-CS-BSDT)}{TA}$ [2]
Busch and Hoffmann (2011) *Business & Sociey*	Q, ROE, ROA	GHG-intensity, market value, leverage, four regional dummy variables, 9 industry dummy variables.	cross-sectional regressions	9 industries: manufacturing, transport and energy utilities	$\frac{MVEQ+(LTD+CL)}{TA}$ [3]
Guenster et al. (2011) *European Financial Management*	Q_{ia}, ROA_{ia}	eco-efficiency score, sales growth, firm age truncated, total assets, ROA	inference over results from cross-sectional estimations	all	$\frac{MVCS+(TA-CS-BSDT)}{TA}$ [2]
Elsayed and Paton (2005) *Structural Change and Economic Dynamics*	Q, ROA, ROS	community & environmental responsibility scores, total assets, R&D intensity, advertisement intensity proxied by intangible assets to sales, leverage, capital intensity, industry dummies	random- and fixed firm effects, also using GMM	all	$\frac{MVCS+(PS+LTD+INV+CL-CA)}{TA}$ [4]
King and Lenox (2002) *Management Science*	Q, ROA	waste & emission measures from TRI, total assets, sales growth, capital intensity, leverage, R&D intensity, regulatory stringency of the states, firm environmental permits	random- and fixed firm effects, the later also with an instrument variable	TRI sample (manufacturing firms)	$\frac{MVEQ+(LTD+CL)}{TA}$ [3]
King and Lenox (2001) *Journal of Industrial Ecology*	Q	emission measures from TRI, total assets, sales growth, capital intensity, leverage, R&D intensity, regulatory stringency of the states, firm environmental permits	random and fixed firm effects	TRI sample (manufacturing firms)	$\frac{MVEQ+(LTD+CL)}{TA}$ [3]
Konar and Cohen (2001) *The Review of Economics and Statistics*	Q	Toxic chemicals (from TRI) intensity &environmental lawsuits, market share, industry concentration ratio, sales growth, advertisement intensity, R&D intensity, total assets, import intensity	cross-sectional regressions	eliminate nonpolluting industries (banking and insurance) from S&P 500 sample	$\frac{MVCS+(LTD+STD+PS)}{(PPE+CH+STI+RV+INV)}$ [4]
Dowell et al. (2000) *Management Science*	Q, ROA, ROS	scope of environmental standards, total assets, R&D intensity, advertisement intensity, leverage, % foreign sales, industry dummies	group mean- and random firm effects regressions	S&P 500 screened for manufacturing and mining firms	$\frac{MVEQ+(LTD+CL)}{(INV+PPE)}$

* Q: Tobin's Q, ROA: Return on assets, Q_{ia}/ROA_{ia}: Industry adjusted Q/ROA, ROS: Return on sales, α: Alpha from a portfolio approach

* MVEQ: Market value of equity, MVCS: Market value of common stock, BSDT: Balance sheet deferred taxes, CA: Current assets, CL: Current liabilities, INV: Inventory, LTD: Long-term debt, PPE: Property-plant-equipment, PS: Preferred stock, RV: Receivables, STD: Short term debt, STI: Short term investments

[1,2,3,4] [1]Same as La Porta et al. (2000); Doidge et al. (2004). [2] Same as Gompers et al. (2003); Kaplan and Zingales (1997). [3] Same nominator as Dowell et al. 2000 Dowell et al. (2000). [4] Similar to Chung and Pruitt (1994)

Table A2.7: Company-years

	UK	USA
	Nr. of firms	Nr. of firms
2003	30	35
2004	45	60
2005	60	80
2006	72	109
2007	95	132
Total	302	416

Table A2.8: Firms per ICB-sector

	UK		USA	
	Nr. of firms	% share	Nr. of firms	% share
Basic Materials	39	13	44	11
Consumer Goods	51	17	55	13
Consumer Services	55	18	20	5
Healthcare	18	6	39	9
Industrials	85	28	51	12
Oil & Gas	18	6	40	10
Technology	7	2	38	9
Telecommunications	6	2	5	1
Utilities	23	8	124	30
Total	302	100	416	100

Table A2.9: Summary statistics, UK

	Nr. firm-years	Median	Mean	Std	Min	Max
logQmv	302	0.52	0.57	0.39	-0.32	1.72
laglogemi	302	-2.57	-2.27	1.98	-8.16	3.80
size	302	14.63	14.80	1.60	11.16	18.66
capint	302	0.04	0.05	0.04	0.00	0.21
leverage	302	0.25	0.25	0.15	0.00	0.65
salesgra	302	6.81	10.05	15.00	-17.97	81.79
rdint	302	0.00	0.02	0.06	0.00	0.48
cashint	302	0.08	0.10	0.08	0.00	0.53
ppe	302	0.25	0.52	0.71	0.01	4.54
ebit	302	0.12	0.15	0.11	-0.15	0.52
foreign_sales	302	53.30	48.82	32.03	0.00	100.00
closely_held	302	11.43	13.88	15.65	0.00	81.24
logage	302	3.51	3.34	1.13	0.00	4.78
indicator_adr	302	0.00	0.47	0.50	0.00	1.00

Table A2.10: Summary statistics, USA

	Nr. firm-years	Median	Mean	Std	Min	Max
logQmv	416	0.42	0.53	0.43	-0.16	1.90
laglogemi	416	-1.31	-1.59	2.59	-7.97	2.82
size	416	16.59	16.67	1.19	12.36	20.49
capint	416	0.05	0.06	0.03	0.00	0.21
leverage	416	0.28	0.28	0.14	0.00	0.67
salesgra	416	8.45	9.85	11.64	-18.93	67.83
rdint	416	0.00	0.03	0.05	0.00	0.29
cashint	416	0.06	0.10	0.10	0.00	0.56
ppe	416	0.43	0.78	0.71	0.01	4.64
ebit	416	0.14	0.15	0.09	-0.17	0.47
foreign_sales	416	35.66	33.09	27.76	0.00	100.00
closely_held	416	0.51	7.63	14.36	0.00	80.16
logage	416	3.62	3.50	1.02	0.00	4.83

Table A2.11: Pairwise correlation tables for UK and USA

	logQmv	laglogemi	size	capint	leverage	salesgra	rdint	cashint	ppe	ebit	foreign_sales	closely_held	logage	indicator_adr
						UK								
logQmv	1.000													
laglogemi	−0.159 * **	1.000												
size	−0.096*	0.261 * **	1.000											
capint	0.148 * **	0.258 * **	0.013	1.000										
leverage	−0.228 * **	0.160 * **	0.221 * **	0.026	1.000									
salesgra	0.084	0.191 * **	−0.013	0.143 * *	−0.116 * *	1.000								
rdint	0.159 * **	−0.232 * **	0.001	−0.215 * **	−0.202 * **	0.009	1.000							
cashint	0.257 * **	−0.071	−0.075	−0.141 * *	−0.159 * **	−0.102*	0.150 * **	1.000						
ppe	−0.148 * *	0.468 * **	0.211 * **	0.407 * **	0.320 * **	0.189 * **	−0.158 * **	−0.120 * *	1.000					
ebit	0.346 * **	0.317 * **	0.316 * **	0.266 * **	0.053	0.289 * **	−0.019	0.058	0.459 * **	1.000				
foreign_sales	0.147 * *	0.168 * **	0.275 * **	0.027	−0.128 * *	−0.015	0.138 * *	−0.002	−0.013	0.228 * **	1.000			
closely_held	0.037	0.067	−0.095	0.052	−0.126 * *	0.115 * *	−0.044	0.055	−0.009	0.053	0.005	1.000		
logage	−0.051	−0.270 * **	−0.175 * **	−0.118 * *	−0.068	−0.200 * **	−0.207 * **	−0.128 * *	−0.185 * **	−0.234 * **	0.085	−0.226 * **	1.000	
indicator_adr	0.107*	0.071	0.660 * **	0.119 * *	0.020	−0.065	0.109*	0.024	0.093	0.308 * **	0.362 * **	−0.149 * **	−0.035	1.000
						USA								
logQmv	1.000													
laglogemi	−0.526 * **	1.000												
size	−0.146 * **	−0.038	1.000											
capint	−0.029	0.217 * **	−0.139 * **	1.000										
leverage	−0.436 * **	0.408 * **	0.009	−0.084*	1.000									
salesgra	0.132 * **	−0.014	−0.091*	0.181 * **	−0.089*	1.000								
rdint	0.446 * **	−0.524 * **	−0.007	−0.180 * **	−0.374 * **	−0.029	1.000							
cashint	0.485 * **	−0.543 * **	−0.021	−0.192 * **	−0.467 * **	−0.028	0.543 * **	1.000						
ppe	−0.510 * **	0.742 * **	−0.020	0.229 * **	0.427 * **	−0.092*	−0.370 * **	−0.424 * **	1.000					
ebit	0.284 * **	0.095*	0.145 * **	0.041	0.009	0.048	0.104 * *	0.128 * **	0.314 * **	1.000				
foreign_sales	0.528 * **	−0.497 * **	0.079	−0.219 * **	−0.296 * **	−0.026	0.439 * **	0.442 * **	−0.554 * **	0.031	1.000			
closely_held	0.032	−0.156 * **	−0.263 * **	0.012	0.023	−0.009	−0.039	0.172 * **	−0.105 * *	−0.125 * *	0.101 * *	1.000		
logage	0.276 * **	−0.231 * **	0.186 * **	−0.069	−0.127 * **	−0.105 * *	0.147 * **	0.145 * **	−0.214 * **	0.056	0.294 * **	−0.126 * *	1.000	

* p< 0.10, ** p< 0.05, *** p< 0.01. Variable indicator_adr is for USA obviously always equal to 0 and therefore not considered.

Table A2.12: Dynamic estimations with selected industries, UK

	(1) Fixed effects	(2) Fixed effects, clustered by firm	(3) Arellano Bond, one-step	(4) Arellano Bond, two-step
L.logQmv	0.220 * **	0.220 * **	0.194	0.130
	[3.23]	[4.17]	[1.26]	[0.55]
laglogemi	−0.113 * **	−0.113 * **	−0.108 * **	−0.083 * **
	[−4.34]	[−4.08]	[−4.17]	[−2.86]
size	−0.124*	−0.124	−0.321 * **	−0.371 * **
	[−1.81]	[−1.50]	[−3.10]	[−3.31]
capint	1.536 * *	1.536	0.915	0.032
	[2.08]	[1.65]	[0.93]	[0.03]
leverage	−0.208	−0.208	−0.011	0.079
	[−1.10]	[−1.04]	[−0.07]	[0.43]
salesgra	−0.002	−0.002	−0.002*	−0.001
	[−1.52]	[−1.63]	[−1.83]	[−0.63]
rdint	−3.280 * *	−3.280 * **	−4.171 * **	−3.222*
	[−2.18]	[−3.16]	[−2.69]	[−1.69]
cashint	−0.135	−0.135	−0.102	−0.047
	[−0.62]	[−0.52]	[−0.45]	[−0.18]
ppe	−0.322 * **	−0.322 * **	−0.314 * **	−0.226 * *
	[−4.32]	[−5.81]	[−3.39]	[−1.99]
ebit	−0.152	−0.152	−0.519 * *	−0.411
	[−0.65]	[−0.61]	[−1.98]	[−1.26]
foreign_sales	0.003 * **	0.003*	0.003 * *	0.002
	[2.62]	[1.79]	[2.20]	[1.21]
closely_held	−0.002	−0.002	−0.002*	−0.002*
	[−1.48]	[−1.51]	[−1.85]	[−1.77]
constant	2.123 * *	2.123*	5.223 * **	5.953 * **
	[2.13]	[1.71]	[3.51]	[3.70]
year dummies	*Yes*	*Yes*	*Yes*	*Yes*
Observations	257	257	170	170
Nr. of firms	84	84	63	63
Nr. of instruments			26	26
AR1 test p-value			0.38	0.49
AR2 test p-value			0.837	0.792
Sargan test p-value			0.331	0.537

t statistics shown in brackets. Significance levels: * p< 0.10, ** p< 0.05, *** p< 0.01.

Only four digit SIC codes bellow 5000 are used and observation deleted with codes between 4931 - 4999 (Energy Utilities). The scenario with SIC codes bellow 5000 and dropping the two digit SIC code 49 (Electric, Gas and Sanitary Services) gives very similar results.

The columns (1) to (6) show the results of different dynamic panel models with a lagged dependent variable as explanatory variable. In (1) and (2) show fixed effects results with clustered standard errors by firm in (2). The robust Arellano-Bond one and two step estimators are presented in (3) and (4).

Table A2.13: Dynamic estimations with selected industries, USA

	(1) Fixed effects	(2) Fixed effects, clustered by firm	(3) Arellano Bond, one-step	(4) Arellano Bond, two-step
L.logQmv	0.312 * **	0.312 * **	0.029	−0.207
	[5.31]	[4.22]	[0.20]	[−1.29]
laglogemi	−0.051 * *	−0.051 * *	−0.046*	−0.042
	[−2.13]	[−2.21]	[−1.84]	[−1.33]
size	−0.375 * **	−0.375 * **	−0.474 * **	−0.526 * **
	[−7.02]	[−4.37]	[−4.49]	[−4.57]
capint	1.122 * **	1.122 * *	0.634	0.770
	[2.66]	[2.49]	[1.22]	[1.09]
leverage	−0.269	−0.269	−0.214	0.010
	[−1.64]	[−1.24]	[−0.91]	[0.04]
salesgra	−0.000	−0.000	−0.001	−0.000
	[−0.37]	[−0.41]	[−0.52]	[−0.19]
rdint	0.717	0.717	0.278	−0.102
	[0.69]	[0.64]	[0.19]	[−0.05]
cashint	0.487 * **	0.487*	0.265	0.413
	[2.73]	[1.90]	[0.97]	[0.94]
ppe	−0.040	−0.040	−0.083	−0.100
	[−0.64]	[−0.45]	[−1.10]	[−1.19]
ebit	0.202	0.202	0.298	0.374*
	[1.41]	[0.99]	[1.55]	[1.76]
foreign_sales	0.000	0.000	−0.001	−0.003
	[0.32]	[0.26]	[−0.64]	[−1.29]
closely_held	−0.000	−0.000	−0.000	−0.000
	[−0.16]	[−0.16]	[−0.27]	[−0.35]
constant	6.447 * **	6.447 * **	8.347 * **	9.326 * **
	[7.20]	[4.56]	[4.91]	[4.96]
year dummies	*Yes*	*Yes*	*Yes*	*Yes*
Observations	396	396	251	251
Nr. of firms	139	139	103	103
Nr. of instruments			26	26
AR1 test p-value			0.14	0.81
AR2 test p-value			0.535	0.927
Sargan test p-value			0.024	0.057

t statistics shown in brackets. Significance levels: * p< 0.10, ** p< 0.05, *** p< 0.01.

Only four digit SIC codes bellow 5000 are used and observation deleted with codes between 4931 - 4999 (Energy Utilities). The scenario with SIC codes bellow 5000 and dropping the two digit SIC code 49 (Electric, Gas and Sanitary Services) gives very similar results.

The columns (1) to (6) show the results of different dynamic panel models with a lagged dependent variable as explanatory variable. In (1) and (2) show fixed effects results with clustered standard errors by firm in (2). The robust Arellano-Bond one and two step estimators are presented in (3) and (4).

Chapter 3

Voluntary corporate climate initiatives and regulatory loom: Batten down the hatches *

Abstract

King and Lenox (2001) argued that "when does it pay to be green" might be a more important question for firms than whether it pays at all. We present an event study that suggests that it pays in the tangible presence of regulatory pressure, depending on how well the chosen scheme to become green fits with the threatened regulatory design. To this end, we exploit the unexpected passage of the Waxman-Markey Bill in 2009. This bill came as a surprise and brought the US economy on the brink of a nationwide CO_2 emission trading system. We use this event to study whether firms with memberships in two well-known voluntary environmental programs to curb carbon emission, the Chicago Climate Exchange and the Climate Leaders, were rewarded by the stock market when the likelihood of federal legislation targeting carbon emissions suddenly increased. To complement the picture, we examine the prior market response to membership announcements. As yet, empirical evidence on both issues does not present a coherent picture. We unravel the intrica-

*This paper is joint work with Dragan Ilić

cies by standardizing the statistical methods and integrating the datasets. Our results suggest that only membership in tailored programs is considered beneficial. Crucially, a substantial part of the market reaction consists of industry-wide effects. In contrast to previous findings, we find no evidence that mere membership announcements triggers a market reaction. Our findings shed light on investors' expectations of climate change policies and their value perception of voluntary carbon reduction programs.

3.1 Introduction

The latest assessment report of the Intergovernmental Panel on Climate Change once again stresses the critical impact of CO_2 emissions on the environment. Still, it does not seem likely that an agreement on a global framework to tackle climate change is achieved anytime soon. Notably the United States as the leading nation in greenhouse gas emissions lacks federal legislation that address carbon emissions on firm level. [1] Neither did any signs credibly point into that direction until 26 June 2009, when the US House of Representatives narrowly passed H.R. 2454: The "American Clean Energy and Security Act of 2009". Dubbed the Waxman-Markey Bill, this act aimed to cap CO_2 emissions in the US by means of an emission trading system. The passage of this bill caught the public off guard. Even though the Senate eventually defeated the bill later on, its success in the House of Representatives unexpectedly and substantially increased the likelihood of federal carbon legislation in the US.

Some firms seemed prepared in light of this looming change in legislation. Apart from signaling credibility and commitment, voluntary (but nevertheless binding) environmental initiatives provide a learning environment to improve one's corporate footprint. With the goal to curb CO_2 emissions in the US, two initiatives launched in the early 2000s stand out. The Climate Leaders (CL) program was an industry-government partnership to help firms reduce emissions of six major greenhouse gases. Participating members pledged to a realistic reduction goal within a five to ten year timeframe. The second initiative could be considered a direct predecessor of the government-based emission trading system intended by the Waxman-Markey Bill. The so-called

[1] There are regional efforts, e.g.: California has recently introduced a cap-and-trade program. However, the large number of allocated pollution permits weigh heavy on their price. Other initiatives encompass several states. The Regional Greenhouse Gas Initiative aims to reduce greenhouse gases in nine US states in the northeast and is limited to large fossil fuel power plants.

Chicago Climate Exchange (CCX) was a trade platform for CO_2 certificates. Its members agreed to a reduction goal and independent verification of their efforts.

Against this background, this paper addresses two questions. First, it asks whether being prepared for CO_2 regulation pays off for firms. More precisely, we employ an event study to analyze whether corporate membership in the CCX or CL initiative was immediately rewarded by the financial markets in view of the unanticipated rise of likelihood of federal legislation. If this is the case, one motivation for firms to join such voluntary programs might be preparation for regulation. On that note, Bruce Braine, vice president of strategic policy analysis for American Electric Power described the motivation to participate in the CCX as follows: "Many of us were doing this not only to make voluntary commitments, but as a way that we could get prepared for a mandatory future. [...] We were learning the ropes, learning about trading and trying to become more proficient in reducing our carbon footprint over time." We are not the first to exploit this event. A similar study by Gans and Hintermann (2013) comes to the conclusion that, evaluated on a monthly basis, the passage of the Waxman-Markey Bill was associated with positive returns for CCX firms. [2]

The second question this paper tackles is how, if at all, the mere announcement to join a voluntary environmental initiative is gaged by the stock market. Existing empirical evidence is ambiguous. Fisher-Vanden and Thorburn's (2011) event study analyzes the immediate stock market reactions for firms announncing their membership to the CL program. In the seeming absence of regulatory pressure, these firms were vigorously penalized in terms of falling stock prices. These results give reason to believe that engagement in voluntary programs are perceived as detrimental from an investor's point of view. On the other hand, investors might perceive voluntary carbon reduction programs as a fitting training ground for an expected mandatory carbon

[2]National Geographic, daily news, November 3 2010

market. In this case, stock market reactions in light of an abrupt increase in the likelihood of legislation should be favorable. Other empirical evidence is consistent with this view. In their study, Gans and Hintermann (2013) come to the conclusion that the stock market reacted favorably towards firms announcing membership to the CCX.

At first glance, this contradicting evidence seems puzzling. We argue that the ambiguity hinges on two issues. For one, test statistics of short-horizon event studies (like the one in Fisher-Vanden and Thorburn) are better specified than those of long-horizon event studies because they are less sensitive to the benchmark model of normal returns and issues of cross-sectional or time-series dependence of abnormal returns (Kothari and Warner, 2007). Gans and Hintermann (2013) employ a difference-in-differences framework on a monthly basis when evaluating the effects of membership announcements and the Waxman-Markey Bill on CCX firms. Their results are highly instructive, but the approach is rather unusual in the context of unexpected events. The large time window associated with monthly data and particularly the lack of consideration for confounding events gives pause. Brown and Warner (1980), for instance, document the problem of using monthly data by illustrating that the degree of misspecification in event tests can be severe. And in a well-known replication study, McWilliams and Siegel (1997) highlight the importance of accounting for such confoundings. In other words, it is not clear to what extent the identified positive return effect for the CCX firms in Gans and Hintermann is attributable to the two events in question, the membership announcements and the Waxman-Markey Bill. By the same token, it would be illuminating to know how CL firms, in addition to their negative reaction upon membership announcement, fared during the passing of the Waxman-Markey Bill. The structure of the CCX program differs substantially from the CL initiative and relies heavily on a market mechanism to curb CO_2 emissions. Does the conflicting evidence on membership announcements for the CCX and the CL initiative translate to the Waxman-Markey Bill? A comparison of the two programs in light of the Bill would yield com-

plementary evidence about the value perception of voluntary initiatives in critical times.

This paper reconciles the existing findings and contributes to a more comprehensive picture. We fill two explanatory gaps and highlight the role of industry-wide effects . First, we add to the conclusiveness of the statistical inference on the effects of both membership announcement and the Waxman-Markey Bill on CCX members. The surprising nature of these events lends itself exceptionally well to conducting an event study. Our second contribution consists in the direct comparison of two distinct initiatives for both events. To this end, we extend the analysis of the impact of the Waxman-Markey Bill to CL firms. This extension yields complementary evidence to the preparation argument. Since the market deemed the value of becoming a member in these two programs differently, we might also observe disparate market reactions in light of the Waxman-Markey Bill. In particular, an environmental program that is tailored to the specific threat of future regulation by means of a cap-and-trade system is likely to be a more effective tool to mediate the effect of an according shock. Put differently, we would expect the CCX cap-and-trade program to receive more goodwill from the market during the passage of the Bill.

Our results are in line with this argument. Conservative estimates suggest that stock prices of CCX members experienced on average positive abnormal returns of 0.7 percent during the passage of the Waxman-Markey Bill. CL members, on the other hand, hardly provoked any significant market reaction. Our analysis suggests that industry-wide market reactions play an important role when evaluating suddenly looming environmental costs. When analyzing the impact of the bill, it turns out that these industry effects explain a substantial part of the observed reaction for the CCX firms and fully absorb the effect that is otherwise attributable to CL membership. Finally, our event study finds no measurable market reaction for firms announcing membership to the CCX. This qualifies previous findings.

The rest of the paper is structured as follows. The next section provides

background information on the Waxman-Markey Bill, the two voluntary environmental programs in our sample, and the related literature. Section 3 lays out the event study methodology, followed by the description of our data in Section 4. The results of the two event studies are presented in Section 5, and the last section concludes.

3.2 Background

3.2.1 Waxman-Markey

H.R. 2454, the "American Clean Energy and Security Act of 2009" was a bill to propose, among other things, the introduction of a cap and trade system. The bill, also known as the Waxman-Markey Bill, was to regulate the emission of greenhouse gases in the United States, in particular CO_2. Remaining the last industrialized country solely oriented towards voluntary programs, the bill was to replace existing voluntary action with mandatory legislation. Under the new legislation, over the next 40 years carbon emissions would be increasingly capped up to 83% of 2005 levels. Allocated with certain CO_2 allowances, the regulated firms would be free to trade their pollution rights at market prices. Although constituting the most prominent element of the legislation, the contents of the bill extend beyond the cap-and-trade system. It was a comprehensive policy to address climate change. As such, it included requirements of "creating a combined energy efficiency and renewable electricity standard and requiring retail electricity suppliers to meet 20% of their demand through renewable electricity and electricity savings by 2020" and "setting a goal of, and requiring a strategic plan for, improving overall U.S. energy productivity by at least 2.5% per year by 2012 and maintaining that improvement rate through 2030".[3]

After months of negotiations, on Friday June 26 2009 at 7:17 p.m. the House of Representatives passed the bill by a vote of 219 to 212. The outcome

[3] http://www.govtrack.us/congress/bills/111/hr2454, visited on October 9 2012

remained uncertain to the end and stirred up subsequent emotions, pointing towards a controversial and unforeseen decision. The media response proclaimed the legislation as historic for the United States and a victory for the Obama administration. Although it remained to be seen whether the Senate would approve the bill as well, the decision in the House of Representatives left the country stunned and raised questions about the immediate impact on the economy. For some time, there was good reason to believe that firms would face substantial costs in terms of CO_2 reduction efforts in the near future.

3.2.2 Chicago Climate Exchange and Climate Leaders

Two major initiatives to curb greenhouse gas emissions in the US were launched roughly ten years ago. In 2003, the Chicago Climate Exchange (CCX) started trading operations of the first cap-and-trade system in North America with 13 charter members that made voluntary but legally binding commitments to reduce six different types of greenhouse gas emissions.[4] By definition, the exchange was characterized by a market mechanism, a platform where prices were considered and allowances exchanged, and where strategic interaction took place. As part of its cap-and-trade scheme the CCX relied on a carbon offset program with its own standards for allowances and offset credits, called "Carbon Financial Instrument" contracts. Established emission baselines and emission reports were verified independently. The CCX was characterized by two distinct phases. From 2003 to 2006 members had to cut their emissions annually by 1% bellow their baseline average defined as from 1998 to 2001. In the second phase from 2007 to 2010, existing members had to cut emissions annually by 0.5% while new members had to cut emissions by 1.5%.

The CCX was characterized by a comprehensive market structure with different participants. Apart from the direct emitters, the CCX members,

[4]CCX Fact Sheet, December 2011. https://www.theice.com/publicdocs/ccx/CCX_Fact_Sheet.pdf, visited on January 14 2013

there were associate members, offset providers, liquidity providers and exchange participants. Overall, the exchange had around 400 members with annual membership fees ranging from 1,000-60,000 USD[5], depending on firm size and membership type. In November 2010, the CCX announced that it would cease its operation, arguing that firms were no longer interested in trading emission credits in the absence of government legislation (Financial Times). The low price of CO_2 emission allowances indicates that the firms' emission reduction targets were not very stringent and that therefore firms expected and indeed did over comply with their commitments. A further source of the cheap emission allowances might also be the criticized weak additionality requirement of CCX (Kollmuss et al., 2008).

The Climate Leaders Greenhouse Gas Inventory Protocol (CL) is the second voluntary initiative we study. Formed in 2002, the initiative was based on the Greenhouse Gas Protocol developed by the World Resources Institute and the World Business Council for Sustainable Development. The CL covered six major greenhouse gas emissions categorized into direct emissions (known as Scope 1), indirect emissions (known as Scope 2), and offered the reduction of optional emissions (known as Scope 3). Climate Leaders was an industry-government partnership initiated by the US Environmental Protection Agency (EPA) that worked with companies to develop comprehensive climate change strategies. Upon becoming a partner, the EPA assisted the company in developing inventory and inventory management plans. Partners then set a corporate-wide domestic or global five to ten year greenhouse gas reduction goal and reported annual inventory data to EPA. In addition, partners were to document their progress towards the goal (Tonkonogy and Oliva, 2007). Members did not only profit form EPA's technical assistance but EPA guaranteed also publicity for the members.

Four types of reduction goals were eligible for CL members: absolute, normalized, indexed, or carbon neutrality. Upon engagement, the EPA eval-

[5] http://co2offsetresearch.org/policy/CCX.html, visited on December 20 2012

uated the proposed reduction goals from all partners, requiring an aggressive reduction compared to the projected GHG performance of the sector. Partners were also allowed to develop their own mitigation offset projects or purchase certified mandatory or voluntary GHG reductions, provided that the projects adhered to approved EPA methodologies. In contrast to the CCX, there were no explicit market mechanisms at work. Upon joining, it was not rational decision-making based on market prices that influenced the daily carbon business. According to the EPA, partners were sure to receive high level recognition via participating in meetings, public outreach, or press events (Tonkonogy and Oliva, 2007). On September 15 2010, the EPA announced their decision to shut down the program in light of new developments in regulatory and voluntary initiatives.

3.2.3 Related literature

To an economist, voluntary participation in these two initiatives may seem puzzling at first glance. Traditional economic analysis assumes that firms already behave optimally, with pollution being an inevitable side product of production (Cropper and Oates, 1992). Reducing production voluntarily thus moves in lockstep with lower use of input, pushing the firm away from optimal production. Some critics, however, counter that it is questionable whether firms make optimal use of inputs in the first place and see room for improvement. This discussion has become popular as the "engergy efficiency gap". Allcott and Greenstone (2012) suggest that the paradigm of efficient energy consumption does not seem too far-fetched, but their conclusion does not seem final (Nadel and Therese, 2012). In this sense, membership in voluntary initiatives might be helpful for optimal input allocation.

It turns out that one can explain voluntary participation in a number of other ways. The literature identifies a variety of rational motives, some of which are based on some sort of imperfect markets (for an overview, see Khanna, 2002). The motives can be roughly divided into market motives and

political motives (Fleckinger and Glachant, 2011). Let us first discuss market motives.

Consumers with preferences for environmental friendly products may encourage product differentiation (McWilliams and Siegel, 2001; Baron, 2001; Besley and Ghatak, 2007). A firm can convey its inclination towards green consumers more credibly if it joins an initiative that verifies the according pledges independently. To this end, membership in voluntary initiatives could serve as a signaling device. The financial market could harbor another catalyst for green behavior. If there is pressure (or better yet, incentive) for green engagement from investors, some firms could be at an advantage. Acclaimed green firms in the limelight of green investors might benefit from lower capital costs caused by sub-optimal diversification (Merton, 1987; Heinkel et al., 2001). In turn, this benefit creates an incentive for polluting firms to go green (Baron, 2008). Disentangling the entity of the firm opens up the door to a different kind of benefit from membership in voluntary initiatives. From a corporate governance perspective, a firm might not seek to cater exclusively to its principals, the shareholders. Instead of acting in the interest of the principal, the firm's manager as the agent aims to maximize his or her own utility function. Tirole (2001) highlights this crucial relationship between shareholder interest and managerial incentive. These mismatched interests can explain green ventures if the manager draws particular utility from doing so, say, by improving his personal status. Yet other market motives include cost-cutting (Allcott and Greenstone, 2012; Bloom et al., 2010) or attracting particularly apt employees (Brekke and Nyborg, 2008).

Political motives constitute the second branch of reasons to go green. Lyon and Maxwell (2003) purport that that by participating in voluntary environmental initiatives, firms seek to pre-empt or shape future public policies. On this note, perhaps the most pertinent argument that rationalizes voluntary participation in our analysis is preparation for some expected legislation. There might be reason to believe that with a non-negligible probability, future environmental legislation will impose costly regulation upon firms. If so,

it is reasonable to dampen the impact of such a future shock by adjusting the behavior today and prepare voluntarily. For a smooth path towards the expected extent of the regulation entails lower overall costs than a sudden adjustment. In contrast, then, to the corporate governance argument, voluntary green engagement is consistent with shareholder value maximization. Unexpected changes in legislation open up a possibility to test this hypothesis. If the markets correctly interprets the impact of suddenly looming legislation, we should observe immediate changes in certain stock prices, plausibly with some firms being affected more than others.

There is empirical evidence that supports the view that a sudden increase in the likelihood of future regulation is taken into account by the market. For instance, Bowen et al. (1983) and Hill and Schneeweis (1983) suggest that the nuclear incident at the Three Mile Island facility in 1979 affected the investors' perception of future regulation by resulting in a sudden drop in share prices for electric utility firms, in particular those who were invested in nuclear power. The chemical disaster in Bhopal in 1984 had a similar effect. Once the extent of the tragedy became clear, the market seemingly anticipated tighter regulation for the entire chemical industry (Blacconiere and Patten, 1994). Unexpected policy changes are likely to affect shareholder value as well. The sudden proposal by President George Bush in 1989 to revise the Clean Air Act triggered a drop in share prices for notoriously polluting firms (Freedman and Patten, 2004). And very recently, the unexpected reaction of the German government to the Fukushima incident affected energy companies' shareholder wealth (Betzer et al., 2013).

By and large, it is fair to assume that anticipated regulation is considered an impending threat by the market. Yet some firms seem to fare better in harsh times. There is reason to believe that voluntary engagement and subsequent verified disclosure is rewarded by the market because of the informational value it delivers when actually facing external shocks. For example, (more extensively) disclosing firms were at an advantage after the chemical leak in Bhopal (Blacconiere and Patten, 1994). The same held true

after the sudden legislation in the US in 1986 to handle contaminated sites (Blacconiere and Northcut, 1997). And firms that were part of the Carbon Disclosure Project experienced an increase in shareholder value when Russia unexpectedly ratified the Kyoto Protocol in 2004 (Kim and Lyon, 2011). Much like the Waxman-Markey Bill, these events qualify as external shocks which increased the likelihood for environmental regulation.

There are two studies that address the value of membership in voluntary environmental initiatives and which are directly related to our paper. The event study by Fisher-Vanden and Thorburn (2011) investigates the announcement effects for firms joining the Climate Leaders program as well as the more vaguely defined Coalition for Environmentally Responsible Economies (CERES). While Fisher-Vanden and Thorburn do not discover any significant market reaction for joining CERES, they find negative abnormal returns for announcing membership in the CL program. On the day of the announcement, stock market returns of respective firms performed one percent worse than expected. Moreover, announcing a binding CO_2 target incurred an additional penalty of 1.1 percent. One characteristic among the CL firms is consistent with the mentioned corporate government argument to go green. The data show that firms are more likely to join the CL program if they exhibit hostile shareholder governance. It therefore seems likely that the market associated the announcements with the managers' discretionary leeway, which was not in the firms' interests.

The second paper that directly relates to our work is the aforementioned study by Gans and Hintermann (2013). Gans and Hintermann investigate stock returns of member firms of the Chicago Climate Exchange on a monthly basis. Contrary to the CL firms in Fisher-Vanden and Thorburn, they find significant positive abnormal returns for firms announcing their membership to the CCX. In addition, Gans and Hintermann take a look at the financial impact of the Waxman-Markey Bill on CCX firms and find a positive market reaction. There are methodological drawbacks, however. The large time frame makes it difficult to isolate the effect of the Waxman-Markey Bill.

This issue is exacerbated by the fact that the impact of the Waxman-Markey Bill was not screened for confounding events at the firm level during the same time frame. We address these issues and extend their analysis. Our paper follows the event study methodology applied in Fisher-Vanden and Thorburn and provides comprehensive results of the impacts of membership announcement for CCX firms on the one hand and the Waxman-Markey Bill for both CCX and CL firms on the other hand. In doing so, the results benefit from higher explanatory power. The next section briefly exposits the event study methodology and highlights its advantage for causal inference.

3.3 Methodology

Event studies have become an indispensable tool in econometrics. MacKinlay (1997) gives a comprehensive overview of the history, theory, and application of event studies in economics. Event studies use financial market information (often stock prices) to deduce the effect of a specific event on the value of a firm. This approach has the advantage that the causal chain is isolated. The event has a direct impact on the stock price, similar to a treatment effect. The statistical inference in an event study relies on three assumptions (McWilliams and Siegel, 1997): Market efficiency, a lack of confounding effects during the event window, and underestimation or no anticipation of the event. Indeed, if the event in question was already anticipated and provided, investors would have already had priced in its predicted impact on firm value. While the passage of the Waxman-Markey Bill was not out of the question, there is empirical evidence that it was indeed largely unexpected and provided the market with new information (Meng, 2013).

The measurement of the impact is carried out by calculating the so-called abnormal stock return. The abnormal return (AR) is the observed return minus the normal return during a specified event window, where the normal return is the return that one would expect to occur if the event had not taken place. The abnormal return $AR_{i\tau}$ is given by equation 3.1, where $E(R_{i\tau}|X_\tau)$

is the expectation of return $R_{i\tau}$ given X_τ.

$$AR_{i\tau} = R_{i\tau} - E(R_{i\tau}|X_\tau) \tag{3.1}$$

In financial economics, the normal return is often modeled via the market model, which relates the return of interest $R_{i\tau}$ to the market return $R_{m\tau}$. In a nutshell, the market model isolates the fraction of the return that is associated with the market return, rendering the return of interest more informative. The parameter estimates of the market model are calculated in an Ordinary Least Square framework on the basis of a preceding estimation window. In addition to the market return, our specification additionally employs the Fama-French's "small minus big" (SMB) and "high minus low" (HML) factors on a daily basis as explanatory variables (Fama and French, 1992, 1993). Kolari and Pynnonen (2010) illustrate that this specification achieves the highest reduction of residual cross-correlation. Taken together, we estimate the following model specifications:

$$R_{i\tau} = \alpha_i + \beta_{i1} \cdot R_{m\tau} + \beta_{i1} \cdot SMB\tau + \beta_{i2} \cdot HML\tau + \epsilon_{i\tau} \tag{3.2}$$

$$R_{i\tau} = \alpha_i + \beta_{1i} \cdot R_{m\tau} + \beta_{2i} \cdot SMB_t + \beta_{3i} \cdot HML + \beta_{4i} \cdot ESret_{jt} + \epsilon_{i\tau} \tag{3.3}$$

$$R_{i\tau} = \alpha_i + \beta_{1i} \cdot R_{m\tau} + \beta_{2i} \cdot SMB_t + \beta_{3i} \cdot HML + \beta_{4i} \cdot BSret_{\gamma t} + \epsilon_{i\tau} \tag{3.4}$$

SMB In equation 3.2 denotes the daily difference of a portfolio of small and big firms, and HML indicates the daily difference of a portfolio of low and high book to market value firms. [6] $\epsilon_{i\tau}$ is the remaining error term after estimating $E(R_{i\tau}|X_\tau)$ and follows from $\epsilon_{i\tau} = AR_{i\tau} = R_{i\tau} - E(R_{i\tau}|X_\tau)$ via equation 3.1. We call the model specified in equation 3.2 the 3 factor model or the baseline specification. We extend this specification by adding industry return factors $ESret_{jt}$ and $BSret_{\gamma t}$ in equation 3.3 and 3.4 respectively

[6] Downloaded from Kenneth French's website: http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

to control for industry effects. In $ESret_{jt}$, j denotes one of 10 economic sectors and in $BUSret_{\gamma t}$, γ denotes one of 25 business sectors according to the Thomson Reuters Business Classification.

The event takes place after the estimation window and is usually placed inside the so-called event window, during which the observed returns are compared to the expected ones. Because some events cannot be unambiguously dated, for example due to gradual information leakage or potential insider information, researchers often include several days around the official date $\tau = 0$. However, this comes at a cost. A longer time series of $AR_{i\tau}$ diminishes the power of the test statistics and tends to increase the number of confounding events. Not to mention that a longer event window is difficult to reconcile with the notion of market efficiency. Contrary to long-horizon event studies, the test statistics of short-horizon event studies are generally less sensitive to the benchmark model of normal returns and issues of both cross-sectional and time-series dependence of abnormal returns (Kothari and Warner, 2007).

In our data, $R_{i\tau}$ is the total return index based on closing prices. The closing price of day $\tau - 1$ is the opening price of day τ. In the event window notation $[T_2, T_3]$, T_2 referres to the opening price on day τ_o and T_3 to the closing price on day τ. The event window $[1, 1]$ therefore captures the return on the day after the event day $\tau = 0$. We are interested in two events, membership announcements and the Waxman-Markey Bill. We define the Waxman-Markey event day, Friday 26 June 2009, as $\tau = 0$ and set the estimation window to 60 trading days from $T_0 = -59$ to $T_1 = 0$. The event day $\tau = 0$ is included in this estimation window because of two reasons: First, the vote took place at 7pm and therefore after the closing of the stock exchanges. Second, the issue of potential information leakage can be excluded because the outcome of the vote was extremely narrow and the public outcry thereafter was substantial. The event window $[1, 1]$ is set narrowly after the event and captures the abnormal returns on day one after the event with $T_2 = 1$ and $T_3 = 1$. A second, longer windows estimates the

returns over $[1, 2]$ until $\tau = 2$. We do not consider longer event windows because the event precedes the weekend, which should provide enough time for the news to spread. For the second event in question, the CCX membership announcments, we extend these narrow windows. It is arguable that the announcements have experienced prior information leakage. To ease the direct comparison with Fisher-Vanden and Thorburn (2011) we choose the following event windows: $[0, 1]$, $[-1, 1]$, and $[-2, 2]$. Setting the estimation window to 60 days sets a span from $T_0 = -62$ to $T_1 = -3$. In turn, the cross-sectional abnormal returns $AR_{i\tau}$ in the event window are cumulated from T_2 until T_3. This yields the cumulative abnormal returns $CAR_{i[T_2,T_3]} = \sum_{\tau=T_2}^{T_3} AR_{i\tau}$. By averaging the CARs across the observations, n average CARs are obtained: $ACAR_{[T_2,T_3]} = \frac{1}{n} \sum_{i=1}^{n} CAR_{i[T_2,T_3]}$.

The raw returns are useful for economic interpretations. Standardized returns, however, have been proven to exhibit better statistical properties (Patell, 1976). The scaled abnormal returns are equal to $SAR_{i\tau} = \frac{AR_{i\tau}}{S(AR_i)}$, where $S(AR_i) = \sqrt{\sigma^2_{\epsilon_i} * [1 + x'_t(X'X)^{-1}x_t]}$ denotes the sampling error correction. The SARs can be cumulated over time as well: $CSAR_{i[T_2,T_3]} = \sum_{\tau=T_2}^{T_3} SAR_{i\tau}$. The cross secional means of these cumulated standardized abnormal returs are equal to $ASCAR_{[T_2,T_3]} = \frac{1}{n} \sum_{i=1}^{n} CSAR_{i[T_2,T_3]}$.

In comparison to a conventional t-test or Patell's test, the test proposed by Boehmer et al. (1991) given in equation 3.5 is robust towards event induced variance inflation. Harrington and Shrider (2013) show that the presence of heterogeneous effects induces event variance and robust tests against cross-sectional variation in the true abnormal return should therefore be preferred.

$$t_{BMP} = \frac{ACSAR \cdot \sqrt{n}}{\frac{1}{n-1} \sum_{i=1}^{n} (CSAR_i - ACSAR)^2} \tag{3.5}$$

An issue for the Waxman-Markey sample is clustering since the event affects all sample firms simultaneously in time. One might therefore question that $\epsilon_{i\tau}$ is independent and identically distributed. MacKinlay (1997) suggests that clustering can be accommodated in two ways. Either by a portfolio

approach which allows for cross correlation of the abnormal returns, or by analyzing the abnormal returns without aggregation, e.g. by including a dummy for the event day. The latter approach has two drawbacks. The test will generally suffer from poor finite sample properties and has little power against reasonable alternatives. As a remedy, Kolari and Pynnonen (2010) propose a modification of the test statistic developed by Boehmer et al. (1991) that is not affected by clustering. Kolari and Pynnonen's statistic increases the cross sectional variance used by Boehmer et al. (1991) by adjusting for the average covariance of the error terms $\bar{\rho}$ during the estimation window:

$$t_{KP} = t_{BMP}\sqrt{\frac{1-\bar{\rho}}{1+(n-1)\bar{\rho}}} \tag{3.6}$$

We consider the Kolari and Pynnonen (2010) test statistic to be the most appropriate for our samples. In addition, we make use of the non-parametric generalized rank test proposed in Kolari et al. (2010) to check the robustness of our parametric tests. We choose the generalized rank test because it has better properties for testing CARs than the conventional rank test and is equally well suited for testing single day abnormal returns.

3.4 Data

In this section, we analyze the announcement effect of the Waxman-Markey bill on both CCX and CL members. In addition, we investigate whether firms announcing CCX membership experience positive abnormal returns in an event study. Gans and Hintermann have kindly provided us with their CCX database and data on their selection process. [7] Their final sample for the Waxman-Markey event consists of 32 firms. We have compiled roughly

[7] Their CCX sample is from 2010, but we found a document form February 2009 that lists the same CCX members: http://www.epa.gov/agstar/documents/workshop09/mccomb.pdf, visited on December 10 2012.

the same number. We start with the same database with 109 members. Of these, 20 are government-affiliated and are cities, states, or universities. From the remaining 89 observations, we find listings for 57 firms in the US. From these listings we drop seven firms with discontinuous price indices, a sign of illiquid securities. From the remaining 53 firms, seven are American Depositary Receipts and three are not major listings or have their book values not denominated in USD. This leaves us with 40 identified CCX member firms.

We complement our database for the Waxman-Markey event with CL firms and their partnership status. Fisher-Vanden and Thorburn identify the announcement effect of firms joining CL (and CERES). In contrast, we identify the effect of the Waxman-Markey Bill on existing CL members. Our database starts with the listed CL members retrieved from the US Environmental Protection Agency as of 8 May 2009.[8]Of the 264 members at this point in time, we focus on the 19 achiever and 87 setter firms. The other 158 so-called developer firms are by definition at a very early stage of their membership. We question their status being an advantage in light of the Waxman-Markey Bill. Indeed, the majority of the developer firms later on opted out of the program, questioning their motivation and commitment in the first place. We exclude these developer firms from our analysis because they presumably just started to consider the impact of their environmental footprint. What is more, this mitigates the concern that these firms might have joined CL in order to free-ride on the program's credibility (Darnall and Carmin, 2005).[9] Although we lack detailed membership status for the day of the passage of the Waxman-Markey Bill, Table A3.5 illustrates the development of the CL program over time. Note in particular the change in the number of firms across all membership categories from 8 May 2009 to 1

[8]Obtained through www.archive.org on November 6 2012 via web.archive.org/web/20090508120744/http://epa.gov/climateleaders/partners/index.html

[9]urlhttp://www.epa.gov/climateleadership/documents/partners_letter_15sep2010.pdf, visited on December 9 2012

August 2010.

Of the 106 Climate Leaders with setter and achiever status, we identify 65 as being listed on a US stock market. Among these stocks, there are five illiquid equity return indices and three ADR listings. This yields an identified sample of 57 CL firms.

The first row of Table A3.6 in the appendix lists the identified firms for both programs. For the Waxman-Markey event samples we conducted a comprehensive analysis of confounding events for an event window from 26 June 2009 (Friday) through 30 June 2009 (Tuesday). For each firm in our database, we searched LexisNexis for unexpected announcements that were published in major US news outlets and which were likely to affect market value during the event window. The second row in Table A3.6 lists the number of confounding events for each program. For the 57 CL firms, we identify 16 confounding events, leaving us with a final CL sample of 41 firms. For the 40 firms in the CCX sample we identify confounding events for nine firms, leaving us with a final CCX sample of 31 firms. An overview of our final samples for the Waxman-Markey event are given in Tables A3.8 and A3.7. Table A3.8 lists the final CL sample with the according membership status and whether the respective firms were charter partners. In addition, the geographic reach of the emission reductions are shown. Table A3.7 lists our final CCX sample and indicates charter member status where applicable. The tables also show that six firms were members in both programs.

In addition to the Waxman-Markey event samples, we are interested in the announcement effect for CCX member firms. To determine this sample we start with the same CCX database and apply the same filters. For the identified firms we search both Google and LexisNexis for membership announcements, resulting in the sample of 26 firms shown in Table A3.6. In contrast to the Waxman-Markey Bill we cumulate abnormal returns for larger event windows due to potential information leakage. Accordingly, we search for confounding events up to two days prior and two days after each membership announcement. We find six confounding events and end up with a

sample of 20 firms.

3.5 Results

This section presents the results of two distinct events. First, we investigate the market reaction to the Waxman-Markey Bill for our three firm samples described in the last section: A CCX sample, a CL sample, and a pooled sample of all firms combined. Second, we take a look at the market reaction to membership announcement for CCX firms, offering a direct comparison to the same reaction towards CL firms in Fisher-Vanden and Thorburn (2011). Taken together, these two events paint a coherent picture of the stock market assessment of the value of membership in voluntary initiatives, both in critical and less critical times.

3.5.1 Event returns: Waxman-Markey Bill

Table 3.1 presents descriptive statistics for the three samples. The pooled sample comprises 61 firms. On their own, the CCX sample consists of 31 firms and the CL sample 41 contains firms, meaning that six firms are members in both programs. The distribution of the market capitalization is positively skewed for the CCX and the CL samples, with CL members being substantially bigger. The two samples differ in the distribution of their sale volumes as well. Although CL firms have, on average, the same turnover as CCX firms, their median is higher. A similar skew is visible in market-to-book numbers. While the average of market-to book equity is the same in both samples, the medians indicate a proclivity for value firms in the CCX sample and for growth firms in the CL sample. The two samples differ in the industry exposure as well. Two economic sectors as classified by the Thomson Reuters Industry Classification are absent from our samples: Telecommunications and Energy. The other economic sectors are not equally distributed, neither across the CL nor the CCX sample. For example, the CCX sam-

Table 3.1: Descriptive statistics

	CL & CCX	**CCX**	**CL**
Number of firms	60	31	41
Market value (MV, billion USD)			
Mean MV	18.1	17.7	24.1
Median MV	6.7	4.8	11.1
Total sales (billion USD)			
Mean sales	20.8	23.2	23.1
Median sales	10.3	9.3	14.4
Market-to-book equity (MEBE)			
Mean MEBE	1.9	2.1	2.0
Median MEBE	2.0	1.3	2.3
Fraction of sample firms in TRBC sector:*			
Basic Materials	0.18	0.32	0.07
Consumer Cyclicals	0.15	0.06	0.20
Consumer Non-Cyclicals	0.05	0.00	0.07
Financials	0.02	0.03	0.02
Healthcare	0.05	0.03	0.07
Industrials	0.15	0.13	0.17
Technology	0.22	0.13	0.29
Utilities	0.18	0.29	0.10

*TRBC: Thomson Reuters Business Classification.

Market value (MV) of equity 7 trading days before June 29 2009.

The mnemonic of sales is WC01001 and of book equity WC03501

ple harbors a larger fraction of basic materials and utilities, whereas the CL sample shows a tilt towards technology firms.

We conduct estimates of abnormal returns for all three samples. To allow for value-relevant information to distribute and sink in, we conduct analyses for two event windows after the passage of the bill. Based on the market model given by equation 3.2 we calculate the cumulated abnormal returns CAR[1,1] for Monday 30 June only and CAR[1,2] for the two trading days after the event.

Table 3.2 presents the abnormal returns and their derivatives according to the 3 factor model, our baseline specification. The results for the event windows [1,1] and [1,2] are depicted in panels A and B, respectively. Across all samples, the average cumulated abnormal returns (ACAR) for the short event window are close to 0.5%. The median of the CAR is larger throughout, most notably for the CCX sample. In contrast, their standardized counterparts (CSAR) are substantially lower with means close to the medians. Of the three samples, the CCX firms exhibit the highest standardized returns. The two-sided test statistic by BMP Boehmer et al. (1991) is highly significant across the board. The null hypothesis of normal returns is well rejected at the 0.1% significance level for the CCX firms and only slighty more so for the CL firms. As expected, the more conservative KP p-values according to Kolari and Pynnonen (2010) are higher (roughly 3% for the CCX firms and 7.6% for CL firms). Finally, the nonparametric generalized rank test supports the rejection of the null hypothesis of normal returns for the short event window.

The cumulated abnormal returns over two days in panel B indicate a negative skew for CL and the pooled sample, whereas the mean and median CARs of the CCX sample are robust and over 0.7%. This suggests that the market incorporated additional price information on the second day after the event. The BMP statistic remains significant across the samples for this longer event window, for the CCX firms once again at the 0.1% level and less so for the CL firms at the 10% level. The KP p-values, however, only remain significant for the CCX and the pooled sample. Put differently, a

conservative estimation suggests that the CL firms do not seem to exhibit abnormal returns when cumulated over two days. Again, the generalized rank test dovetails with the KP test.

Taken together, these results are consistent with the idea that financial markets believe that firms engaging in voluntary measures of carbon emission reduction get a head start in preparing for imminent federal carbon emission legislation. But not all programs encounter equal praise. Based on the results of the market model, membership in the CCX is considered more beneficial in light of the Waxman-Markey Bill compared to membership in the CL program.

All the same, the heterogeneous sector distributions for the CCX and CL firms give pause. The empirical evidence listed in Section 2 suggests that some sectors might experience specific shocks when faced with a carbon cap-and-trade system, depending on their cost exposure. Indeed, the CL and CCX firms are not readily comparable in terms of sector distribution. The results in Table 3.2 are based on the 3 factor model, which benchmarks a firm's returns against the market return and the two Fama-French risk factors SMB and HML. As such, the results are prone to industry-specific effects.

It seems plausible that the Waxman-Markey Bill had distinct effects in different industries. In order to isolate the CCX and CL membership effect, we proceed with controlling for industry-specific confoundings by extending the market model with both economic and, to reach an even deeper level, business sector returns. . In a first step, we incorporate industry return factors from 10 economic sectors. More precisely, for each security i in sector j we add to the market model the economic sector return j as defined in equation 3.3. Table A3.9 in the appendix summarizes the results of this extension. It turns out that economic sector returns explain a substantial part of the observed positive effects. By any measure of statistical significance and for both event windows, the abnormal returns of the pooled sample are no longer different from zero. The two samples on their own present a more nuanced picture. In the previous analysis, the CL sample only showed significant

Table 3.2: 3 factor model

	CL&CCX	**CCX**	**CL**
Panel A: event window[1,1]			
ACAR	0.450	0.437	0.476
CAR Median	0.534	0.740	0.490
ACSAR	0.264	0.324	0.230
CSAR Median	0.241	0.303	0.220
BMP t-statistic	3.403	2.960	2.533
BMP p-val	0.001	0.006	0.015
KP t-statistic	2.298	2.280	1.820
KP p-val	0.025	0.030	0.076
GRank Test	2.745	2.605	2.248
GRank p-val	0.008	0.012	0.028
Nr. of Observations	60	31	41
Panel B: event window[1,2]			
ACAR	0.310	0.789	0.347
CAR Median	0.734	0.766	0.723
ACSAR	0.375	0.540	0.275
CSAR Median	0.393	0.503	0.503
BMP t-statistic	2.937	3.087	1.924
BMP p-val	0.005	0.004	0.061
KP t-statistic	1.983	2.378	1.383
KP p-val	0.052	0.024	0.174
GRank Test	2.105	2.354	1.619
GRank p-val	0.040	0.022	0.111
Nr. of Observations	60	31	41

CAR & CSAR in %. 60 days estimation window from 02apr2009 to 26jun2009. Event window[1,1] captures the abnormal returns on day 26jun2009 and event window[1,2] on 26jun2009 and 30jun2009. The BMP test (Boehmer et al. 1991) is an extension of Patell (1976) and robust to event induced variance. The KP test (Kolary & Pynnönen, 2010) is adjusting the BMP test for cross sectional correlation. In our samples the average correlation of abnormal returns $\bar{\rho}$ is: $\bar{\rho}_{cl\&ccx} = 0.020$, $\bar{\rho}_{ccx} = 0.022$, $\bar{\rho}_{cl} = 0.023$. The non-parametric GRank test is the generalized rank test for cumulated returns from Kolari and Pynnönen (2010a.)

returns for the short event window. This significance disappears with the inclusion of industry-specific effects. The CCX sample, on the other hand, keeps showing (slightly less) significant abnormal returns, in particular for the longer event window. In this window, the CARs and CSARS for the CCX firms are somewhat reduced by introducing industry-specific controls. In sum, the new results indicate that positive sectoral effects have been at work, much more so for the CL than for the CCX sample. The effect for the CCX firms dilutes in the pooled sample.

To further check the robustness of these results, we extend the market model by adding to each security i in business sector γ the business sector return γ. In contrast to 10 economic sectors, we are thus now able to differentiate more subtly by controlling for 25 business sectors. The results for our third and most strict specification, which is formally given by equation 3.4, are presented in Table 3.3. The results reinforce the trend set by the previous specification with 10 economic sectors. In addition to the CL sample, the CCX sample starts losing some of its verve. While there remains evidence of abnormal returns for the longer event window in panel B, controlling for business sectors renders the statistical significance of abnormal returns in the short event window non-significant.

Let us take a closer look at the longer event window for the CCX sample in Table 3. The CARs are positively skewed, with a substantially higher mean than median value. This holds true for the standardized CARs as well. The previous specifications have shown consistently lower p-values for the BMP test in comparison to the KP test. This order has now switched. While the BMP test statistic implies a p-value above the 10% level, the stricter KP p-value retains statistical significance at this level. This switch can be explained by the average correlation of the abnormal returns $\bar{\rho}$, which has become slightly negative. The significance of the KP p-value is supported by the generalized rank test. The analysis suggests that business sector effects explain an additional part of the positive abnormal returns. Further indication that controlling for sectoral effects has increased the explanatory

power is reflected by the changes in correlation of the abnormal returns $\bar{\rho}$ (see the footnotes in the according tables). This value decreases steadily with increasingly detailed model specification and tends to converge towards zero. In sum, CCX firms seem to have profited from the threat of regulation in addition to being overrepresented in favorable sectors.

3.5.2 Event returns: CCX membership announcement

As the second event, we investigate the market reaction to CCX membership announcements. The sample consists of 20 firms announcing their engagement, ranging from the founding members in 2003 up to the last announcements in 2008. Industry-specific effects are less of a concern in this setting. While the Waxman-Markey Bill has shown to have had a sudden and highly focused impact on entire industry sectors at one point in time, mere membership announcements should hardly be confounded by industry-wide effects. Moreover, they are scattered over several years. In contrast to the Waxman-Markey Bill, however, information leakage poses a potential problem. To address the possibility that insider information affected the stock price before the firms' public statements, we extend the event window symmetrically around the announcement dates. In addition to calculating the cumulated abnormal returns over the short window [0,1], we add two longer windows, [-1,1] and [-2,2] to ease the comparison with Fisher-Vanden and Thorburn.

Table 3.4 presents the abnormal return estimates for CCX membership announcement. Over the short window, both the ACAR and the ACSAR are slightly positive. This changes when expanding the event windows, with the longest window exhibiting negative returns across the board. However, none of the results show a statistically significant pattern. All test statistics are well below significance levels and cannot reject the null hypothesis of normal returns in light of the membership announcements. In yet other words, the market was seemingly indifferent to the firms' sudden voluntary engagement in the CCX. Our results qualify the findings in Gans and Hintermann, where

Table 3.3: 4 factor business sector model

	CL&CCX	CCX	CL
Panel A: event window[1,1]			
ACAR	-0.196	-0.260	-0.063
CAR Median	-0.109	-0.042	-0.071
ACSAR	0.029	0.082	0.021
CSAR Median	-0.069	-0.036	-0.039
BMP t-statistic	0.345	0.694	0.213
BMP p-val	0.731	0.493	0.832
KP t-statistic	0.345	0.712	0.199
KP p-val	0.731	0.482	0.844
GRank Test	0.516	0.644	0.577
GRank p-val	0.608	0.522	0.566
Nr. of Observations	60	31	41
Panel B: event window[1,2]			
ACAR	0.259	0.684	0.270
CAR Median	-0.055	0.170	0.096
ACSAR	0.127	0.303	0.074
CSAR Median	-0.016	0.063	0.046
BMP t-statistic	0.962	1.679	0.507
BMP p-val	0.340	0.103	0.615
KP t-statistic	0.964	1.722	0.472
KP p-val	0.339	0.095	0.639
GRank Test	1.005	1.674	0.815
GRank p-val	0.319	0.100	0.419
Nr. of Observations	60	31	41

CAR & CSAR in %. 60 days estimation window from 02apr2009 to 26jun2009. Event window[1,1] captures the abnormal returns on day 26jun2009 and event window[1,2] on 26jun2009 and 30jun2009. The BMP test (Boehmer et al. 1991) is an extension of Patell (1976) and robust to event induced variance. The KP test (Kolary & Pynnönen, 2010) is adjusting the BMP test for cross sectional correlation. In our samples the average correlation of abnormal returns $\bar{\rho}$ is: $\bar{\rho}_{cl\&ccx}$ = -0.000, $\bar{\rho}_{ccx}$ = -0.002 , $\bar{\rho}_{cl}$ = 0.004 . The non-parametric GRank test is the generalized rank test for cumulated returns from Kolari and Pynnönen (2010a.)

Table 3.4: 3 event windows based on the 3 factor model

	[0,1]	**[-1,1]**	**[-2,2]**
ACAR	0.150	-0.213	-0.513
CAR Median	0.210	-0.001	-0.310
ACSAR	0.185	0.168	-0.024
CSAR Median	0.135	-0.013	-0.117
Patell t-statistic	0.813	0.738	-0.107
Patell p-val	0.420	0.464	0.915
BMP t-statistic	0.517	0.319	-0.043
BMP p-val	0.607	0.751	0.966
KP t-statistic	0.455	0.281	-0.038
KP p-val	0.651	0.780	0.970
GRank Test	0.897	0.454	0.011
GRank p-val	0.374	0.651	0.991
Nr. of Observations	20	20	20

CAR & CSAR in %. The 3 factor model parameters are estimated during 59. The BMP test (Boehmer et al. 1991) is an extension of Patell (1976), robust to event induced variance. Kolary & Pyönnen (2010) (KP) extend the BMP test, adjusting for cross sectional correlation. The average correlation of abnormal returns $\bar{\rho}$ in our sample is $\bar{\rho} = 0.015$ The GRank test is the generalized rank test for cumulated abnormal returns from Kolari and Pyonnen (2010a)

a positive market reaction was concluded. Nevertheless, CCX firms seem to provoke a different market reaction upon membership announcement than CL firms do. In Fisher-Vanden and Thorburn, newly announced membership engagement in the CL initiative was vigorously punished with negative abnormal returns.

3.6 Conclusion

When does it pay to be green? This paper studies two events to answer this question. First, we examine the immediate effect of the Waxman-Markey Bill on stock prices for members of two voluntary but binding US environmental initiatives, Climate Leaders (CL) and the Chicago Climate Exchange (CCX). This bill intended to establish a mandated carbon market in the US and unexpectedly passed the vote in the House of Representatives in June 2009, temporarily inducing a credible economic threat in the form of unforeseen costs in the short run. In the second event study, we investigate the market reaction to membership announcements to the CCX.

Our event studies employ the market model augmented by the Fama-French factors (Fama and French, 1992, 1993). In our baseline specification, the reaction to the Waxman-Markey Bill indicates positive abnormal returns for both the CL and the CCX firm samples. However, the existing literature stresses that industry effects may play a role in the attributed impact on firm level. With respect to the Waxman-Markey event in particular, the implementation of the bill would likely have had specific impacts on different industries. For this reason, we isolate the membership effect in a voluntary climate initiative by extending the basic model specification by economic and, on a deeper level, business sector returns. Doing so puts the positive effects into perspective. By and large, members of the Chicago Climate Exchange seemed to profit from the Waxman-Markey Bill despite the confounding industry effects. This finding is in line with Gans and Hintermann (2013), but the observed industry effects dampen the attributed market reaction to CCX

membership. On the other hand, the industry effects fully account for the positive returns for the Climate Leaders.

In a second event study, we investigate the market reaction towards membership announcement. In their event study, Fisher-Vanden and Thorburn found significant negative effects when new CL member announced their engagement. In direct comparison to the immediate negative reaction towards the CL announcements in Fisher-Vanden and Thorburn's event study, how do new CCX members fare? Our results for CCX membership announcement cannot reject a neutral market reaction and qualifies the conclusions of previous findings, where Gans and Hintermann concluded a positve reaction for CCX announcements. We attribute the distinct results in spite of the same event to the methodological differences. Our observed market reaction suggests that the market does not regard the CCX engagement as a detrimental venture. One could argue that the engagement was in line with the market's expectation of the firms' strategies. Obviously, both initiatives entail considerable costs for the firms in the short run. The reaction to the membership announcements suggest that the perceived advantages of membership only outweigh these costs in case of the engagement in the CCX. There only seemed good reason to join the CCX, not the CL initiative.

Taken together, the market reaction in light of the two events paint a consistent picture of the perceived value of membership in the two initiatives. The significant abnormal returns for the Chicago Climate Exchange members during the passage of the Waxman-Markey Bill are likely to be explained by the fact that this program effectively mirrored the workings of a regulatory cap-and-trade system as intended by the bill. Indeed, the CCX can plausibly be considered a blueprint for the emission trading system proposed in the bill. The positive reaction distinguishes the Chicago Climate Exchange from the Climate Leaders, who acquired firm internal knowledge about how to implement an emission management system and how to identify and pursue emission reduction opportunities. Crucially, the Climate Leaders did not profit from participating in an active carbon market, gaining trading experi-

ence and knowledge directly applicable in the foreseen cap-and-trade system. The indifferent market reaction for the Climate Leaders during the passage of the bill is in line with the preparation argument. These results are also consistent with the view that firms do not only join to signal a credible commitment to go green, but gain actual experience which is helpful in light of looming regulation.

We caution to claim external validity for our results. Membership in these initiatives is voluntary and therefore endogenous. Even though we control for firm characteristics in our estimations, we can not control for variables like firm strategy or product differentiation. We would expect firms with higher membership payoffs to be more likely to join. By the same token, it seems reasonable that the observed market reaction for members establishes a upper bound when thinking about a contractual membership of non-member firms. On the other hand, one might argue that the Waxman-Markey event was a regulatory event and therefore less dichotomous as other events. On this note, the observed market reaction rather establishes a lower bound effect.

Based on our results of the two examined events we contend that voluntary initiative alone are clearly not enough to move the whole economy to a lower carbon intensity. But they might complement regulatory regimes. The results of this paper inform about the interaction of voluntary program design and regulation. Interestingly enough, even the Bush administration itself, under which the Climate Leaders program was initiated, did not really believe in the effectiveness of purely voluntary efforts. On this note, The New York Times (2003) wrote that administration officials were collecting written promises from industries to curb greenhouse gas emissions. "White House officials, insisting on concrete commitments measured in tons of gases, have rejected written offers from some industry groups to take nonspecific actions, several industry officials said.... Opponents of regulation have criticized the administration's effort as a mandatory program disguised as a voluntary one."

3.7 Tables

Table A3.5: Climate Leader membership development

Date	**# Firms**	**Achievers**	**Setters**	**Developers**
28.03.2008	162	11	69	82
21.05.2008	172	11	69	92
03.01.2009	249	18	85	146
08.05.2009	264	19	87	158
01.08.2010 *	191	26	93	72
13.02.2011	183	32	100	51

* Retrieved on September 20 2012 from:

http://www.epa.gov/climateleadership/documents/directory.pdf

All other dates are from lists as retrieved from www.archive.org

Table A3.6: Nr. of firms in samples

	Waxman-Marekey event			Membership announcement
	CL&CCX	**CCX**	**CL**	**CCX**
Identified*	84	40	57	26
Confounding events	24	9	16	6
Resulting sample	60	31	41	20

* Identified firms without illiquid firms and ADRs.

Table A3.7: Chicago Climate Exchange firms (CCX) and event samples

Firm name	**Sample membership***		**Charter member**
Abbott Laboratories	MA		
Agrium U.S. Inc.		W&M	
Alliant Energy Corporate Services Inc.		W&M	
American Electric Power	MA	W&M	charter member
Avista Corporation	MA	W&M	
Bank of America Corporation		W&M	
Baxter International Inc.	MA	W&M	charter member
Boise Paper Holdings, LLC	MA	W&M	
CLECO Corporation		W&M	
Central Vermont Public Service	MA	W&M	
Dow Corning		W&M	
DTE Energy Inc	MA	W&M	
DuPont		W&M	charter member
Eastman Kodak Company		W&M	
FMC Corporation		W&M	
Ford Motor Company		W&M	charter member
Genon Energy Inco.	MA		
Green Mnt.Power Corp.	MA		
Intel Corporation	MA	W&M	
Interface, Inc.	MA	W&M	
IBM	MA	W&M	
International Paper		W&M	charter member
Knoll, Inc.	MA	W&M	
MeadWestvaco Corp.	MA	W&M	charter member
Mirant Corporation		W&M	
Motorola, Inc.		W&M	charter member
Neenah Paper Incorporated	MA	W&M	
Nrg Energy Inco.	MA		
Plum Creek Timber Company, Inc.		W&M	
PSEG Energy Resources & Trade LLC		W&M	
Puget Energy Inco.	MA		
Safeway Incorporated	MA		
Steelcase Inc.		W&M	
TECO Energy, Inc.		W&M	
Temple-Inland Inc	MA	W&M	charter member
United Technologies Corporation		W&M	
Waste Management, Inc.	MA	W&M	charter member

Sample membership*: - W&M; Waxman-Markey event sample

- MA; Membership Announcement sample.

Table A3.8: Sample of Climate Leader firms (CL) for Waxman-Markey event

Firm name	**CL status***	**Charter partner**	**Reduction region**
3M	achievers		U.S. GHG
Advanced Micro Devices, Inc.	achievers	charter partner	global GHG
Agilent Technologies	setters		global GHG
American Electric Power	achievers		U.S. GHG
Applied Materials, Inc.	setters		global GHG
Bank of America Corporation	setters		U.S. GHG
Baxter International Inc.	achievers	charter partner	U.S. GHG
Best Buy Co., Inc.	setters		U.S. GHG
Calpine	setters		U.S. GHG
Campbell Soup Company	setters		U.S. GHG
Caterpillar Inc.	achievers		global GHG
Cisco Systems, Inc.	setters		global GHG
Cummins Inc.	setters		global GHG
Dell Inc.	setters		global GHG
DuPont Company	setters		global GHG
Eastman Kodak Company	setters	charter partner	global GHG
Ecolab, Inc.	setters		U.S. GHG
EMC Corporation	setters		U.S. GHG
Fairchild Semiconductor	setters		U.S. GHG
Hasbro, Inc.	achievers	charter partner	U.S. GHG
Intel Corporation	setters		global GHG
Interface, Inc.	setters	charter partner	U.S. GHG
IBM Corporation	achievers	charter partner	global GHG
International Paper	setters	charter partner	U.S. GHG
Johnson Controls, Inc.	setters		U.S. GHG
LSI Corporation	setters		U.S. GHG
Marriott International, Inc.	setters		U.S. GHG
Merck & Co., Inc.	setters		global GHG
Millipore Corporation	setters		global GHG
Coors Brewing Company	setters		U.S. GHG
FPL Group, Inc.	achievers	charter partner	U.S. GHG
NVIDIA Corporation	setters		U.S. GHG
Owens Corning	setters		U.S. GHG
PepsiCo	setters		U.S. GHG
PPG Industries, Inc.	setters		global GHG
PSEG	setters	charter partner	U.S. GHG
Staples, Inc.	setters	charter partner	U.S. GHG
Steelcase Inc.	setters		U.S. GHG
Gap, Inc.	setters		U.S. GHG
United Technologies Corporation	achievers		global GHG
Xerox Corporation	achievers		global GHG

CL status*: Status of Climate Leader member with regard to emission reduction pledge.

Table A3.9: 4 factor economic sector model

	CL&CCX	CCX	CL
Panel A: event window[1,1]			
ACAR	-0.047	0.102	-0.082
CAR Median	0.027	0.181	-0.004
ACSAR	0.073	0.204	0.011
CSAR Median	0.018	0.114	-0.002
BMP t-statistic	0.896	1.829	0.118
BMP p-val	0.374	0.077	0.907
KP t-statistic	0.808	1.796	0.100
KP p-val	0.422	0.082	0.920
GRank Test	1.173	1.903	0.513
GRank p-val	0.245	0.062	0.610
Nr. of Observations	60	31	41
Panel B: event window[1,2]			
ACAR	0.276	0.717	0.294
CAR Median	0.465	0.804	0.380
ACSAR	0.185	0.436	0.063
CSAR Median	0.197	0.403	0.160
BMP t-statistic	1.423	2.479	0.432
BMP p-val	0.160	0.019	0.668
KP t-statistic	1.283	2.435	0.367
KP p-val	0.204	0.021	0.715
GRank Test	1.442	2.247	0.664
GRank p-val	0.155	0.028	0.509
Nr. of Observations	60	31	41

CAR & CSAR in %. 60 days estimation window from 02apr2009 to 26jun2009. Event window[1,1] captures the abnormal returns on day 26jun2009 and event window[1,2] on 26jun2009 and 30jun2009. The BMP test (Boehmer et al. 1991) is an extension of Patell (1976) and robust to event induced variance. The KP test (Kolary & Pynnönen, 2010) is adjusting the BMP test for cross sectional correlation. In our samples the average correlation of abnormal returns $\bar{\rho}$ is: $\bar{\rho}_{cl\&ccx} = 0.004$, $\bar{\rho}_{ccx} = 0.001$, $\bar{\rho}_{cl} = 0.009$. The non-parametric GRank test is the generalized rank test for cumulated returns from Kolari and Pynnönen (2010a.)

Chapter 4

Is socially responsible investing really beneficial? New empirical evidence for the US and European stock markets *

Abstract

This paper empirically examines the theoretically ambivalent relationship between socially responsible investing (SRI) and stock performance. It extends the existing literature by considering both the US and the entire European stock markets and by using consistent world-wide corporate sustainability performance data after a screening process including broad negative screens. Our portfolio analysis from 1998 to 2009 applies the factors from a recently constructed financial databank comprising the common market return, size, value, and momentum factors according to Carhart (1997). These risk factors from the corresponding four-factor model allow us to estimate more reliable risk-adjusted returns than in the restrictive one-factor model based on the

*This paper is joint work with Andreas Ziegler

Capital Asset Pricing Model. In both the US and European stock markets we find that SRI is associated with large-sized firms. However, this investment strategy generally leads to insignificant abnormal returns when all four risk factors are considered so that we find no evidence that SRI is either penalized or rewarded by the stock markets. These results indicate that the penalty imposed through the lack of portfolio diversification due to the application of broad negative screens might have been compensated by a value relevant positive-screening process.

4.1 Introduction

Growing individual awareness of environmental, social, and ethical issues is strongly affecting purchase decisions of market participants, for example, with respect to certified green or fair-trade products (Kitzmueller and Shimshack, 2012). This development is fueling private and institutional investment decisions towards socially responsible investing (SRI), also labeled ethical or sustainable investing (e.g. Renneboog et al., 2008). This investment strategy consists of choosing stocks on the basis of environmental, social, and ethical screens (e.g Barnett and Salomon, 2006). SRI has experienced strong growth around the world. For example, Table A4.3 in the appendix reports that according to Eurosif (2010, 2008), core SRI in Europe grew from 34 billion € in 2002 to 1200 billion € in 2009. This corresponds to an annual growth rate of 66%. For the US, the Forum for Sustainable and Responsible Investment reports that one out of eight invested US dollars (USD) follows SRI guidelines. According to Table A4.4, the assets under management following SRI screening more than quadrupled from 529 billion USD in 1997 to 2512 billion USD in 2010 (see US-Sif, 2010). While these data for the US and Europe should not be compared directly due to different SRI categorization schemes, they reveal the increasing popularity of SRI. This development has attracted academic interest so that several empirical studies examine whether environmental, social, or ethical investments are penalized or rewarded by the stock

markets. Methodologically, these studies use common micro-econometric approaches (e.g Filbeck and Gorman, 2004; Ziegler et al., 2007b), the short-term event study approach (e.g. Teoh et al., 1999; Cañón-de Francia and Garcés-Ayerbe, 2009; Capelle-Blancard and Laguna, 2010; Fisher-Vanden and Thorburn, 2011; Oberndorfer et al., 2013), or portfolio analyses (Derwall et al., 2011; Hong and Kacperczyk, 2009). Most studies in this field are based on the third approach by directly considering the investor perspective, i.e. by comparing the stock performance of SRI funds and portfolios with the stock performance of conventional funds and portfolios.

One direction of such portfolio analyses examines the performance of sustainability stock indexes (e.g. Sauer, 1997; Bauer et al., 2005; Schröder, 2007), such as the Domini 400 Social Index. These stock indexes like the Dow Jones Sustainability Index family (e.g. Ziegler and Schröder, 2010; Ziegler, 2012) constitute the basis for some socially responsible mutual funds. A second group of portfolio analyses compares the risk-adjusted stock returns of socially responsible funds with the corresponding risk-adjusted stock returns of conventional mutual funds (e.g. Bauer et al., 2005, 2007; Capelle-Blancard and Monjon, 2013). However, studies on actively managed mutual funds have the drawback that the SRI impact on financial performance cannot be disentangled from the effects of the ability of asset managers. This problem is addressed by a third group of portfolio analyses, building on synthetic portfolios based on corporate sustainability performance assessments, for example, provided by Innovest (e.g. Derwall et al., 2005) or KLD Research & Analytics (e.g. Kempf and Osthoff, 2007a). Some of these assessments are the basis for popular sustainability stock indexes, such as the Domini 400 Social Index that is constructed with KLD ratings. Theoretically, the stock performance effect of SRI is ambivalent. The following three hypotheses are discussed in the literature (e.g Hamilton et al., 1993; Bauer et al., 2005): First, if SRI increases the value of socially responsible firms by decreasing the expected returns and the cost of capital of these firms, SRI portfolios deliver lower stock returns than conventional portfolios. The second hypothesis is that the stock returns

of SRI portfolios are higher than those of their conventional counterparts if SRI characteristics are not correctly priced by stock markets. Finally, the third hypothesis is that SRI is neither penalized nor rewarded by stock markets if corporate sustainability performance or corporate social responsibility (CSR), referring to corresponding corporate environmental, social, and ethical activities, is not priced. This argument represents the common finance view because in the presence of efficient capital markets and elastic demand curves, SRI can not influence a firm's cost of capital (Wall, 1995). According to the Capital Asset Pricing Model (CAPM), the optimal risk-return portfolio for mean-variance investors is the market portfolio. Portfolios deviating from the market portfolio are not optimally diversified. Merton (1987) extended the CAPM by asymmetric information. This causes segmented markets and asset prices are affected by the combination of different investor bases of assets and imperfect diversification. In line with this model Hong and Kacperczyk (2009) find that sin stocks, companies involved in producing alcohol, tobacco or gambling, are shunned by many investors and have higher expected returns than comparable stocks. The small investor base of these stocks depresses their price and hence raises the expected returns.

We examine SRI portfolios produced by a rating process combining broad negative screens with a positive screening process. A rigorous negative screening process is rare in the SRI industry because the exclusion of many industries might result in poorly diversified portfolios suffering from subpar performance. Whether the positive screening process has identified widely held stocks with an inflated price and depressed expected returns, or value relevant SRI characteristics that compensate or even overcompensate for the poor diversification, can only be examined empirically.

Our portfolio analysis is in line with the aforementioned third direction of studies, i.e. we use raw corporate sustainability performance assessments. The main contribution of this study to the corresponding empirical literature is two-fold: First, in contrast to most former studies, we do not only consider the US stock market, but also analyze the entire European stock market based

on consistent world-wide corporate sustainability performance data from the Swiss bank ZKB (Zurich Cantonal Bank). This allows a comparative analysis for these two world-wide leading stock markets. Second, our portfolio analysis reveals the appeal of a new financial databank that has recently been constructed at the University of Zurich and ETH Zurich (see Schmidt et al., 2011), comprising the common market return, size, value, and momentum factors according to Carhart (1997). These risk factors from the corresponding four-factor model are necessary to estimate risk-adjusted returns that are more reliable than corresponding return estimates in a restrictive one-factor model based on the Capital Asset Pricing Model (CAPM). The risk factors from this flexible multifactor model are publicly available for the US and some other stock markets and have already been applied in former SRI portfolio analyses. However, only our newly elaborated (Pan-)European size, value, and momentum factors allow an analysis for the entire European stock market. In the meantime, Fama and French (2012) have also constructed such factors. But compared to our databank, they are based on a smaller number of European countries and rely on a different financial data provider, namely Bloomberg.

Our portfolio analysis has two dimensions: In a first step, we only examine firms that are included in the Morgan Stanley Capital International (MSCI) World Index. Based on the corporate sustainability performance assessments by ZKB, we construct US and European portfolios comprising firms that are sector leaders in terms of sustainability performance and corresponding portfolios comprising firms that are not sector leaders. These stock portfolios are then used to estimate average monthly risk-adjusted or abnormal returns. Furthermore, we consider a trading strategy of buying stocks of MSCI firms that are sector leaders in terms of sustainability performance and selling stocks of MSCI firms that are not sector leaders. In a second step, we additionally include firms from the US and European stock markets that are not part of the MSCI, but are identified as leaders in terms of sustainability performance by ZKB. We estimate again average monthly risk-adjusted returns

for the corresponding slightly more diversified portfolios. The remainder of the paper is structured as follows:

In section 4.2 we present our portfolio analysis approach and section 4.3 examines the data. The section 4.4 discusses the empirical results and the final section 4.5 concludes.

4.2 Methodological approach

In order to examine whether SRI is penalized or rewarded by the stock markets, our portfolio analysis compares the average stock performance of portfolios comprising firms that differ with respect to their sustainability performance. In line with recent studies (e.g. Derwall et al., 2005; Bauer et al., 2005, 2007; Kempf and Osthoff, 2007a; Ziegler et al., 2011) we consider the risk-adjusted returns of different stock portfolios that are estimated on the basis of asset pricing models. So far, the traditional and most fundamental asset pricing model is the one-factor model based on the market model (e.g. Sharpe, 1963) and the CAPM (e.g. Lintner, 1965; Fama and French, 2004; Perold, 2004). This model can be formulated for a portfolio i in month t $(i = 1, \ldots, N; t = 1, \ldots, T)$ as in equation 4.1:

$$r_{it} - r_{ft} \quad = \quad \alpha_i + \beta_i (r_{mt} - r_{ft}) + \epsilon_{it} \tag{4.1}$$

In this approach $r_i t$ and $r_m t$ are the (continuous) stock returns of portfolio i and the market at the end of month t, $r_f t$ is the risk-free interest rate at the beginning of month t, and ϵ_{it} is the disturbance term with expectation $E(\epsilon_{it}) = 0$ and (unknown) variance $Var(\epsilon_{it}) = \sigma_\epsilon^2$. The one-factor alpha α_i (i.e. Jensen's alpha) and β_i are further unknown parameters, which are estimated by ordinary least squares (OLS). This model assumes that β_i captures the non-diversifiable risk of each stock portfolio in the explanation of the excess returns $r_{it} - r_{ft}$.

Based on the "anomalies" discussion questioning the validity of the CAPM (e.g. Banz, 1981; DeBondt and Thaler, 1985; Fama and French, 1992), Fama and French (1993) have developed a three-factor model, which includes - in addition to the excess returns $r_{mt} - r_{ft}$ of the stock market - two factors with respect to size and value to explain the excess portfolio returns $r_{it} - r_{ft}$. Many empirical studies show that this three-factor model has more explanatory power than the one-factor model based on the CAPM, for example, Fama and French (1993, 1996) for the US, Berkowitz and Qiu (2001) for the Canadian, Hussain et al. (2002) for the British, and Schrimpf et al. (2007) or Ziegler et al. (2007a) for the German stock market. With the emergence of this three-factor model the discussion about an additional factor, namely the momentum factor, began (e.g. Jegadeesh and Titman, 1993, 2001; Rouwenhorst, 1998) and resulted in the following four-factor model of Carhart (1997), which is currently the most common asset pricing model for general applications in financial economics (e.g. L'Her et al., 2004; Bollen and Busse, 2005) including SRI portfolio analyses:

$$r_{it} - r_{ft} = \alpha_i + \beta_{i1}(r_{mt} - r_{ft}) + \beta_{i2} SMB_t + \beta_{i3} HML_t + \beta_{i4} WML_t + \epsilon_{it} \qquad (4.2)$$

In this model 4.2 the Fama-French size factor SMB_t is the difference between the returns of portfolios comprising stocks of "small" firms and portfolios comprising stocks of "big" firms at the end of month t. The Fama-French value factor HML_t is the difference between the returns of portfolios comprising stocks of firms with a "high" book-to-market equity ratio and portfolios comprising stocks of firms with a "low" book-to-market equity ratio at the end of month t. Finally, the Carhart momentum factor WML_t is the difference between the returns of portfolios comprising stocks of recent "winners" and portfolios comprising stocks of recent "losers" at the end of month t. The unknown parameters are now the four-factor alpha α_i as well as β_{i1}, β_{i2}, β_{i3} and β_{i4} in addition to $Var(\epsilon_{it}) = \sigma_\epsilon^2$ and are again estimated by OLS.

The parameter of principal interest is α_i and is interpreted as the average monthly risk-adjusted or abnormal return of stock portfolio i not explained by the single risk factor in the one-factor model based on the CAPM or by the four risk factors in the Carhart multifactor model. In the following, the alphas thus measure the stock return out- or underperformance of portfolios comprising firms that are or are not sector leaders in terms of sustainability performance compared with the stock market. Furthermore, we consider for the group of MSCI firms a trading strategy of buying stocks of firms that are sector leaders and selling stocks of firms that are not sector leaders in terms of sustainability performance. For this long-short strategy we examine returns of stock portfolios that are calculated by the difference between the returns of portfolios. The corresponding alphas can be calculated by the difference between the two separated one- or four-factor model alphas.

4.3 Data

4.3.1 Corporate sustainability performance data

In our study we use corporate sustainability performance data from ZKB, the biggest cantonal bank in Switzerland and one of the leading suppliers of SRI products on the Swiss financial market. ZKB employs a team of analysts with the mandate to identify firms that can be considered as sustainability leaders. Compared with other suppliers of SRI products, the screening process of ZKB is rigorous since a positive screening is preceded by a broad negative screening process. Firm preclusion criteria of the negative screening process comprise main business operations centered around: Production of fossil energies, operation of energy plants based on fossil energies or nuclear energy, production of cars or planes, airlines, production of ozone depleting substances, production of harmful substances according to the Stockholm agreement, not sustainable fishery or forestry, production of nuclear reactors, operations related to genetically modified organisms, production of weapons

or military machines, as well as production of tobacco and cigarettes.

During the assessment process the analyst team of ZKB consults firm documents such as annual reports and CSR reports as well as various environmental and social governance databases. The negative screening is followed by a consultation of important media to ensure that the firms are not involved in any problematic controversies as well as a best-in-class approach. The resulting assessment from this annual process is dichotomous and identifies firms leading their sector in terms of sustainability performance. Such firms are not said to have no improvement potential, but have a more in-depth approach to environmental, social, and corporate governance issues than their competitors. It should be noted that ZKB - in line with other suppliers of SRI products - focuses on firms with higher market values (including all MSCI firms) compared with the entire stock market universes. This size difference has to be considered when the results of our portfolio analysis are interpreted. An analysis with a rather small group of small- to medium-sized firms based on an alternative assessment concept of ZKB can be found in Mollet et al. (2013).

Based on these corporate sustainability performance assessments, we consider three portfolios on the US and European stock markets. The portfolio 'sustainability leaders' comprises in each year firms that are general sector leaders in terms of sustainability performance. The portfolio 'MSCI sustainability leaders' comprises in each year the group of sustainability leaders among all MSCI firms over time, and the portfolio 'other MSCI firms' comprises in each year the group of MSCI firms that are not sustainability leaders. The portfolio 'MSCI sustainability leaders' is thus a sub-group of the portfolio 'sustainability leaders' since the latter comprises both the sector leaders in terms of sustainability performance among all firms in the MSCI as well as some sustainability leaders that are not part of the MSCI. Additionally, we also analyze long-short portfolios on the basis of a trading strategy of buying stocks of sustainability leaders in the MSCI and selling stocks of the other firms in the MSCI that are not sector leaders in terms of sustainability

performance.

4.3.2 Financial data: A new databank

Our financial data, particularly for the factors in the four-factor model according to Carhart (1997), stem from a new databank that has recently been constructed at the University of Zurich and ETH Zurich (for details of the following discussion, see Schmidt et al., 2011). In line with Ince and Porter (2006), the starting point of the construction of the databank is the Thomson Reuters Datastream constituent lists. Besides research lists, we use additional lists from Thomson Reuters Worldscope and Thomson Reuters Datastream to control for survivorship bias and to get a population as large as possible. After some static screens to firm characteristics we extract time series data for these firms. The time series draws have a yearly frequency for Thomson Reuters Worldscope data and a monthly frequency for Thomson Reuters Datastream data. In order to correct the monthly data, we apply dynamic screens as suggested by Ince and Porter (2006) as well as additional filters. Overall, for the whole time series we use 13343 US firms and 11054 European firms to construct the stock market return factor, and slightly less firms to construct the SMB, HML and WML factors.

Using only US firms listed on the NYSE, AMEX, or NASDAQ at the end of the sample period would result in a sample suffering from survivorship bias. Therefore, we choose to use all firms that are available on Thomson Reuters Datastream and Thomson Reuters Worldscope. This implies that our US sample is drawn from a different population compared with the population described by Fama and French (1993). Data of European firms that are traded after January 2002 are denominated in Euros, whereas data of firms that are delisted before January 2002 are denominated in the old currency of the respective country. This can be fixed by using the fixed Euro conversion rate and expressing all cash values (like size) in Euro values. Furthermore, for some European countries dividend data are obviously erroneous. We correct

this issue by applying the following procedure: If a dividend payment is higher than 50% of the adjusted price, we divide the Thomson Reuters Datastream dividend by a certain value. We apply this screen also for the US stock market, although this issue is not of practical relevance there.

The book-to-market equity ratio for the sorting month June is calculated as book equity divided by size (i.e. the market value) of the preceding December. To be included in the June sort of year τ, a firm must have a positive book value and size available in December of the previous year $\tau - 1$. In order to construct the SMB and HML factors for the US and European stock markets, all remaining stocks are sorted each December into three book-to-market equity ratio groups. Furthermore, we sort these stocks each June into two size groups. From the intersection of the two size groups "small" (S) and "big" (B), and the three book-to-market equity ratio groups "low" (L), "medium" (M), and "high" (H), we form six portfolios, which are held for one year. The six portfolios contain stocks of firms with small size and low book-to-market equity ratio (S/L), with small size and medium book-to-market equity ratio (S/M), with small size and high book-to-market equity ratio (S/H), with big size and low book-to-market equity ratio (B/L), with big size and medium book-to-market equity ratio (B/M), as well as with big size and high book-to-market equity ratio (B/H). From the monthly value weighted returns of these six portfolios we construct the SMB and HML factors for month t as follows:

$$SMB_t = \frac{r_t^{S/L} + r_t^{S/M} + r_t^{S/H}}{3} - \frac{r_t^{B/L} + r_t^{B/M} + r_t^{B/H}}{3} \tag{4.3}$$

$$HML_t = \frac{r_t^{S/H} + r_t^{B/H}}{2} - \frac{r_t^{S/L} + r_t^{B/L}}{2} \tag{4.4}$$

$r_t^{X/Y}$ denotes the returns of a stock portfolio belonging to size class X (S or B) and book-to-market equity ratio class Y (H, M, or L) in month t based on the portfolio formation in last June. In order to construct the

WML factor, we calculate for each portfolio formation month $t-1$ and for each stock the mean return from month $t-12$ to month $t-$ and use this mean return to compile three momentum groups. This sorting takes place every month. We also construct two size groups each month. To be included in the sort, the stock return has to be available in every month from $t-12$ to $t-2$ and size must be available in month $t-1$. From the intersection of the two size groups S and B and the three momentum groups "losers" (L), "medium" (M), and "winners" (W), we form six portfolios. The six portfolios contain stocks of firms with small size and loser momentum (S/L), with small size and medium momentum (S/M), with small size and winner momentum (S/W), with big size and loser momentum (B/L), with big size and medium momentum (B/M), as well as with big size and winner momentum (B/W). We construct the WML factor for month t as the difference between the mean returns of the two winner portfolios and the mean returns of the two losers portfolios:

$$WML_t = \frac{r_t^{S/W} + r_t^{B/W}}{2} - \frac{r_t^{S/L} + r_t^{B/L}}{2} \tag{4.5}$$

$r_t^{X/Z}$ denotes the returns of a stock portfolio belonging to size class X (S or B) and momentum class Z (W, M, or L) in month t based on the portfolio formation in month $t-1$. In each of the above sorts, we need to choose breakpoints to divide portfolios. In order to mirror the Fama and French (1993) NYSE breakpoints, we choose to use in our analysis of a broader sample the 0.80 quantile as a breakpoint for the separation of stocks of firms with small and big size as well as the 0.30 and the 0.70 quantiles to separate among the three book-to-market equity ratio groups and the three momentum groups.

4.3.3 Descriptive statistics

Table A4.5 reports the number of sample firms in the three portfolios 'sustainability leaders', 'MSCI sustainability leaders', and 'other MSCI firms' across industries according to the Industry Classification Benchmark (ICB), separately on the US and European stock markets. Table A4.6 shows the number of sample firms across the European countries as classified by Thomson Reuters Datastream according to the home or listing country of a stock. For reasons of brevity we only report the cross-sectional distributions for the last year with full coverage, i.e. 2008, in Table A4.5 and A4.6 . In this year the US portfolios comprise 591 firms and the European portfolios 575 firms. In the US most firms stem from the financial sector (110), followed by firms from the industrials industry (89). This pattern is similar for Europe with 129 industrial and 127 financial firms, although the order is narrowly reversed. With respect to the US sustainability leaders, the highest number of firms is from the technology sector. In contrast, the highest numbers of European sustainability leaders are in the industrials, financials, consumer services, and consumer goods sectors. Overall, the European stock market contains a substantially higher number of sustainability leaders than the US stock market in 2008. Table 4.1 reports the numbers of sample firms and average market values from 1998 to 2009 for the three portfolios 'sustainability leaders', 'MSCI sustainability leaders', and 'other MSCI firms'. While the upper part of the table refers to the US, the lower part refers to the European stock market. The table shows that the number of European sustainability leaders is not only in 2008 but in each year higher than the number of US sustainability leaders. This result is not implying that European firms are more sustainable than US firms because this disparity could also be driven by a higher focus of ZKB on the European stock market.

Table 4.1 also reports that the number of sustainability leaders strongly increases over time in both regions. Moreover, the table points to a further size tilt in the US: Not only the average size of the assessed firms is higher

Table 4.1: Number of firms and average market value in portfolios over time

US

Year	Sustainability leaders		MSCI sustainability leaders		Other MSCI firms	
	No. of firms	ϕ market value*	No. of firms	ϕ market value*	No. of firms	ϕ market value*
1998	11	46.47	8	62.57	282	23.68
1999	16	59.18	9	98.29	286	29.43
2000	24	44.70	14	68.66	289	28.72
2001	25	43.71	14	71.30	252	28.22
2002	23	32.96	17	41.33	356	19.91
2003	26	41.19	20	50.04	348	22.96
2004	35	54.19	27	67.00	400	21.23
2005	42	53.85	37	59.26	447	20.78
2006	41	53.09	36	58.56	497	21.50
2007	42	53.02	37	58.24	501	21.96
2008	42	30.71	38	32.73	549	11.53
2009	37	32.46	33	32.39	449	13.44

Europe

Year	Sustainability leaders		MSCI sustainability leaders		Other MSCI firms	
	No. of firms	ϕ market value*	No. of firms	ϕ market value*	No. of firms	ϕ market value*
1998	29	24.95	24	27.03	367	9.10
1999	45	20.15	24	32.49	384	11.85
2000	56	17.25	29	27.07	389	12.28
2001	62	14.81	32	24.03	387	10.06
2002	64	11.09	38	17.86	435	8.59
2003	61	14.11	40	20.47	416	11.18
2004	71	16.83	54	21.27	416	14.31
2005	105	16.62	81	20.72	424	14.06
2006	113	21.66	89	26.40	434	16.76
2007	113	24.46	93	28.34	445	19.87
2008	120	9.61	95	11.16	455	9.80
2009	124	11.42	98	13.84	441	9.12

* Mean market value of portfolio in billion USD

compared with the entire stock market universes, but also the average market values of sustainability leaders and particularly of MSCI sustainability leaders are in each year distinctly higher than the average market values of other MSCI firms that are not sustainability leaders. A similar but less pronounced size difference between sustainability leaders and MSCI firms that are not sustainability leaders can be observed on the European stock market. But the size differences between the three portfolios 'sustainability leaders', 'MSCI sustainability leaders', and 'other MSCI firms' on the European stock market decrease over time, whereas they remain stable on the US stock market. Table A4.7 reports average monthly returns across the full time period of our analysis from 01/1998 to 04/2009 on the US (upper part) and European (lower part) stock markets. Additionally, the table reports the returns for the three sub-periods 01/1998-08/2001, 09/2001-08/2005, and 09/2005-04/2009. While the first and last sub-periods comprise 44 months, the sub-period from 09/2001 to 08/2005 spans 48 months in order to include the 2001 terrorist attack on the world trade centre in New York and its financial markets implications. The average monthly returns (in %) are reported for the entire stock markets, the risk-free interests, the SMB, HML, and WML factors as well as for the portfolios 'sustainability leaders', 'MSCI sustainability leaders', and 'other MSCI firms'. The monthly risk-free interest rates rft for Europe is proxied by the Fibor for the year 1998 and by the Euribor from 1999 to 2009. For the US the monthly interbank offered rate is used. Since all our financial data are finally denominated in USD, the returns are also calculated on this basis. The average monthly risk-free interest rate amounts to 0.31% (annually 3.8%) over the full time period for both regions. The average monthly return on the European stock market amounts to 0.29% and is substantially higher than the 0.08% on the US stock markets. In both regions the strongly negative returns in the last sub-period are striking. Out of the three risk factors, the WML factor delivers the highest average returns over the full time period on the US and European stock markets. Furthermore, this risk factor has positive average returns in all sub-periods. In contrast,

the average returns of the SMB factor are in both regions negative in the first sub-period, substantially positive in the second sub-period and in the last sub-period negative in the US and slightly positive in Europe. The focal point in Table A4.7 are the average monthly stock returns for the three portfolios. While the returns across the full time period are positive for the MSCI firms that are not sustainability leaders, the corresponding average returns for the portfolios 'sustainability leaders' and 'MSCI sustainability leaders' are negative in both regions. In line with the average monthly returns on the stock markets, the returns for all three portfolios continuously decrease over time in the US so that they are even negative in the last sub-period. While the average returns in Europe are also negative for all three portfolios in the last sub-period, the portfolio 'other MSCI firms' has the highest positive average return in the sub-period from 09/2001 to 08/2005 in this region. However, the average monthly stock returns for the portfolio 'other MSCI firms' are in all sub-periods and in both regions more positive than the returns of the sustainability leaders. A naive interpretation of this result not taking heterogeneity into account would consider this as evidence for a negative relationship between corporate sustainability performance and stock performance. However, Table 4.1 already shows an important driver of heterogeneity, namely a size tilt of the sustainability leaders. By conducting a more reliable portfolio analysis as discussed in the second section, the results from the univariate descriptive statistics are scrutinized in the following.

4.4 Results

4.4.1 Aggregated results

Table 4.2 reports the estimation results in one- and four-factor models across the full time period from 01/1998 to 04/2009 for the portfolios 'sustainability leaders', 'MSCI sustainability leaders', 'other MSCI firms', as well as for the long-short portfolio as discussed above. The upper part of this table refers to

the US stock market, while the lower part refers to the European stock market. For each portfolio the first row reports the results in the one-factor model based on the CAPM, while the second row reports the respective results in the Carhart four-factor model. In order to control for possible distortions due to heteroskedasticity or autocorrelation in the disturbance term, only the robust heteroskedasticity- and autocorrelation-consistent z-statistics according to Newey and West (1987) are reported besides the parameter estimates. In line with common practice (e.g. Greene, 2002), we assume a possibly autocorrelated error structure up to three lags. The estimation results point to the high practical relevance of the application of the four-factor model compared with the restrictive one-factor model and thus of our new financial databank. The results in the four-factor model reveal in both regions a significantly negative loading of the SMB factor. This finding is not surprising since the average monthly returns of the SMB factor are according to Table A4.7 positive on the US and European stock markets across the full time period from 01/1998 to 04/2009 (which illustrates that small-sized firms outperformed large-sized firms during this time period) and since the three portfolios comprise firms with a higher average market value than the entire stock market universes. Furthermore, the WML factor has a significantly negative loading for all three portfolios in Europe. As a consequence, the significantly negative alphas for the portfolio 'sustainability leaders' and particularly for the long-short portfolio on the European stock market seem to be misleading since they only refer to the application of the one-factor model and become insignificant on the basis of the four-factor model. The main result of Table 4.2 are therefore the insignificant alphas in both regions for all portfolios in the four-factor model with the exception of a significantly positive abnormal return for the portfolio 'other MSCI firms' in the US.

Table 4.2: Parameter estimates in one- and four-factor models for different portfolio returns, full time period: 01/1998-04/2009

	US					
	Alpha	$r_{mt} - r_{it}$	SMB_t	HML_t	WML_t	R^2
	−0.26	0.94 ∗ ∗	–	–	–	0.77
Sustainability	(−1.18)	(22.88)	–	–	–	
leaders	−0.16	0.93 ∗ ∗	−0.15∗	−0.05	−0.06	
	(−0.69)	(16.64)	(−1.92)	(−0.67)	(−1.11)	0.79
	−0.28	0.96 ∗ ∗	–	–	–	0.77
MSCI sustain-	(−1.15)	(20.98)	–	–	–	
ability leaders	−0.18	0.96 ∗ ∗	−0.18 ∗ ∗	−0.02	−0.05	0.78
	(−0.74)	(16.77)	(−2.34)	(−0.29)	(−0.91)	
	0.02	0.96 ∗ ∗	–	–	–	0.97
Other MSCI	(0.33)	(70.38)	–	–	–	
firms	0.10 ∗ ∗	0.99 ∗ ∗	−0.21 ∗ ∗	−0.02	−0.01	0.99
	(2.01)	(54.91)	(−8.81)	(−1.48)	(−0.57)	
	−0.31	0.00	–	–	–	−0.01
Long-short:	(−1.22)	(0.07)	–	–	–	
MSCI firms	−0.28	−0.03	0.02	0.00	−0.05	−0.02
	(−1.09)	(−0.42)	(0.29)	(0.03)	(−0.79)	
	Europe					
	Alpha	$r_{mt} - r_{it}$	SMB_t	HML_t	WML_t	R^2
	−0.46∗	0.92 ∗ ∗	–	–	–	0.70
Sustainability	(−1.77)	(11.08)	–	–	–	
leaders	−0.11	0.81 ∗ ∗	−0.52 ∗ ∗	0.01	−0.20 ∗ ∗	0.77
	(−0.36)	(9.43)	(−3.59)	(0.06)	(−2.31)	
	−0.38	0.92 ∗ ∗	–	–	–	0.71
MSCI sustain-	(−1.51)	(11.49)	–	–	–	
ability leaders	−0.04	0.81 ∗ ∗	−0.50 ∗ ∗	−0.05	−0.17∗	0.77
	(−0.13)	(9.68)	(−3.40)	(−0.38)	(−1.93)	
	0.02	0.93 ∗ ∗	–	–	–	0.8
Other MSCI	(0.11)	(13.82)	–	–	–	
firms	0.23	0.85 ∗ ∗	−0.44 ∗ ∗	0.05	−0.11∗	0.84
	(0.93)	(13.14)	(−3.66)	(0.51)	(−1.66)	
	−0.40 ∗ ∗	−0.00	–	–	–	−0.01
Long-short:	(−2.72)	(−0.14)	–	–	–	
MSCI firms	−0.26	−0.04	−0.07	−0.10	−0.06	0.00
	(−1.61)	(−1.15)	(−0.84)	(−1.10)	(−1.01)	

* (**, ***) means that the appropriate parameter is different from zero at the 10% (5%, 1%) significance level, respectively.

Values in () are the robust z-statistic.

4.4.2 Results for different time periods and sectors

However, it could be argued that these aggregated estimation results are not able to disclose possible abnormal returns in some sub-populations. In order to examine whether the estimation results differ over time (e.g. due to changing expectations or risk-premia) or between several sectors, we consider disaggregated estimations. In a first step we examine different time periods and in a second step we exclude financial firms. Table A4.8 and Table A4.9 report besides the full time period 01/1998-04/2009 the estimation results for the three sub-periods 01/1998-08/2001, 09/2001-08/2005, and 09/2005-04/2009. Due to the superiority of the Carhart four-factor model as discussed above, we omit the estimation results in the restrictive one-factor model based on the CAPM. Table A4.8 therefore reports the estimation results in the four-factor model on the US, while Table A4.9 refers to the corresponding results on the European stock market. Table A4.8 reveals that the significantly positive abnormal return across the full time period from 01/1998 to 04/2009 for the US portfolio 'other MSCI firms' is strongly affected by the alpha estimate of 0.36 in the first sub-period from 01/1998 to 08/2001. This significant abnormal return becomes insignificant in the second and third sub-periods. In line with the aggregated estimation results in Table 4.2, we find neither on the US stock market (see Table A4.8) nor on the European stock market (see Table A4.9) significant abnormal returns in any sub-period for the portfolios 'sustainability leaders' 'MSCI sustainability leaders', and the long-short portfolio. This time disaggregated analysis therefore confirms the main result in Table 4.2. The insignificant abnormal returns are also confirmed when firms from the financial sector are excluded. The comparison between financial firms and firms from other sectors is generally of interest due to their strong differences in their valuation by the markets and their accounting rules (e.g. Ziegler et al., 2011; Ziegler, 2012), which could influence the estimation results in our portfolio analysis. In addition, the separation of commercial and investment banking was suspended in 1999 in the US by the repeal of the

Glass-Steagall Act and financial firms were strongly affected by the stock market turbulences during the considered time period. Therefore, Table A4.10 (for the US stock market) and Table A4.11 (for the European stock market) report the corresponding estimation results in the four-factor model for the sub-group of non-financial firms and for all sub-periods besides the full time period. Overall, the tables reveal qualitatively identical estimation results as Table A4.8 and Table A4.9. In line with Table A4.8, Table A4.10 reports for the US stock market a significantly positive abnormal return for the portfolio 'other MSCI firms' in the first sub-period from 01/1998 to 08/2001 and - as a consequence - across the full time period from 01/1998 to 04/2009. The higher magnitude of the estimated alphas for non-financial MSCI firms that are not sustainability leaders compared with all MSCI firms that are not sector leaders in terms of sustainability performance suggests that the financial firms negatively affect the significantly positive abnormal return for this portfolio. However, the main result in Table A4.10 and Table A4.11 are again the insignificant alphas in all sub-periods for the portfolios 'sustainability leaders', 'MSCI sustainability leaders', and the long-short portfolio in the US as well as in all sub-periods and for all portfolios in Europe.

4.5 Conclusion

This paper empirically analyzes the theoretically ambivalent effects of SRI on stock performance on the US and the European stock markets. The basis of our identification of SRI are consistent world-wide corporate sustainability performance data from ZKB. Methodologically, we examine in our portfolio analysis the risk-adjusted returns of different stock portfolios that are estimated on the basis of asset pricing models. Our study underlines the superiority of the application of the Carhart four-factor model compared with the restrictive one-factor model based on the CAPM. We show that the estimation results in the one-factor model are misleading and that the size factor is of particular importance in the four-factor model. Our study thereby illustrates

the high relevance of a recently developed financial databank, comprising - to the best of our knowledge - as a novelty the Carhart risk factors for the entire European stock market. This new databank certainly provides a rich basis for future analyses of the relationship between corporate sustainability performance and stock performance such as portfolio analyses or long-term event studies (e.g. Barber and Lyon, 1997) as well as for studies in financial economics in general.

Another main result of our paper are the generally insignificant abnormal returns for SRI on both stock markets. As a single exception, we find some positive abnormal returns for firms in the MSCI that are not sector leaders in terms of sustainability performance. But these abnormal returns arise only on the US stock market and only in the first sub-period from 01/1998 to 08/2001 becoming insignificant over time. While the general result of insignificant abnormal returns could be disappointing for the appeal of SRI, our results do not suggest that this investment strategy is penalized either on the US or on the European stock market. Given the rigorous application of negative screens during the selection process, this result suggests that the lack of diversification might have been compensated by a value-relevant positive screening-process.

With respect to the investor perspective, our portfolio analysis with corporate sustainability performance data from ZKB additionally reveals that SRI is often exposed to a size tilt. We show that not only the primarily assessed firms are on average larger than the entire stock market universes, but also that the average market values of the sustainability leaders within this population are distinctly higher than the average market values of less sustainable firms. It should be noted that the identification of sustainability leaders by ZKB within a population of firms with high market values as basis for SRI is not an exemption. For example, the assessments for the construction of the Dow Jones Sustainability Index family are similarly based on large-sized firms (e.g. Ziegler and Schröder, 2010). These assessment processes therefore strengthen the relevance of the application of multifactor models for analyses

of the effects of SRI on stock performance.

4.6 Tables

Table A4.3: Core SRI assets under management in Europe

Year	2002	2005	2007	2009
Billion €	34	105	511.7	1200

Source: Eurosif (2008, 2010)

Table A4.4: Assets under management following SRI screening in the US

Year	1995	1997	1999	2001	2003	2005	2007	2010
Billion USD	162	529	1497	2010	2143	1685	2098	2512

Source: US Sif (2010)

Table A4.5: Number of firms in portfolios across industries in 2008

	Sustaintainability leaders		MSCI sustain-ability leaders		Other MSCI firms	
	US	Europe	US	Europe	US	Europe
Basic Material	3	5	3	5	23	35
Consumer Good	8	17	6	15	56	49
Consumer Service	6	19	5	18	77	62
Financial	3	25	3	17	107	102
Healthcare	7	7	7	6	53	21
Industrial	3	26	2	16	86	103
Oil & Gas	1	5	1	5	45	27
Technology	10	6	10	6	56	19
Telecommunication	1	4	1	3	10	14
Utility	-	6	-	4	36	23
Overall	42	120	38	95	549	455

Table A4.6: Country of origin of European firms in portfolios in 2008

Country	Sustainability leaders	MSCI sustainability leaders	Other MSCI firms
Austria	2	1	13
Belgium	3	3	18
Denmark	5	5	17
Finnland	6	5	17
France	8	7	62
Germany	14	10	36
Greece	-	-	15
Hungary	1	-	-
Ireland	1	-	10
Italy	3	1	32
Netherlands	4	4	18
Norway	3	3	17
Portugal	-	-	9
Spain	5	4	27
Sweden	11	11	30
Switzerland	20	9	26
United Kingdom	34	32	108
Overall	120	95	455

Table A4.7: Average monthly returns (in %) for different portfolios and time periods

	US							
Time period	r_{mt}	r_{ft}	SMB_t	HML_t	WML_t	Sustainability leaders	MSCI sustainability leaders	other MSCI firms
01/1998-04/2009	0.08	0.31	0.21	0.23	0.62	−0.20	−0.23	0.11
01/1998-08/2001	0.56	0.45	−0.14	0.40	1.01	0.33	0.40	0.81
09/2001-08/2005	0.36	0.15	0.83	0.77	0.34	−0.05	−0.11	0.22
09/2005-04/2009	−0.71	0.33	−0.11	−0.52	0.53	−0.91	−0.99	−0.71
	Europe							
Time period	r_{mt}	r_{ft}	SMB_t	HML_t	WML_t	Sustainability leaders	MSCI sustainability leaders	other MSCI firms
01/1998-04/2009	0.29	0.31	0.19	0.48	0.99	−0.22	−0.14	0.29
01/1998-08/2001	0.38	0.30	−0.33	0.36	0.84	0.18	0.45	0.47
09/2001-08/2005	1.18	0.23	0.81	0.99	0.97	0.11	0.12	0.86
09/2005-04/2009	−0.78	0.39	0.03	0.05	1.16	−0.98	−1.00	−0.53

r_{mt}: Stock market return

r_{ft}: Risk-free interest

SMB_t: Size factor

HML_t: Value factor

WML_t: Momentum factor

Table A4.8: Parameter estimates for the US stock market in four-factor models for different portfolios and time periods

	Time period	Alpha	$r_{mt} - r_{it}$	SMB_t	HML_t	WML_t	R^2
Sustainability leaders	01/1998-04/2009	−0.16	0.93 ∗ ∗	−0.15∗	−0.05	−0.06	0.79
		(−0.69)	(16.64)	(−1.92)	(−0.67)	(−1.11)	
	01/1998-08/2001	−0.10	1.05 ∗ ∗	−0.05	0.06	−0.07	0.68
		(−0.17)	(6.71)	(−0.38)	(0.35)	(−1.01)	
	09/2001-08/2005	0.33	1.04 ∗ ∗	−0.56 ∗ ∗	−0.38 ∗ ∗	0.11 ∗ ∗	0.87
		(0.96)	(16.98)	(−4.63)	(−3.35)	(2.11)	
	09/2005-04/2009	−0.21	0.81 ∗ ∗	−0.02	0.10	−0.16∗	0.90
		(−0.76)	(7.73)	(−0.10)	(0.59)	(−1.88)	
MSCI sustainability leaders	01/1998-04/2009	−0.18	0.96 ∗ ∗	−0.18 ∗ ∗	−0.02	−0.05	0.78
		(−0.74)	(16.77)	(−2.34)	(−0.29)	(−0.91)	
	01/1998-08/2001	−0.06	1.07 ∗ ∗	−0.06	0.08	−0.07	0.67
		(−0.09)	(6.41)	(−0.56)	(0.45)	(−1.00)	
	09/2001-08/2005	0.34	1.08 ∗ ∗	−0.64 ∗ ∗	−0.40 ∗ ∗	0.13 ∗ ∗	0.86
		−0.94	(16.21)	(−5.07)	(−3.67)	(2.11)	
	09/2005-04/2009	−0.24	0.85 ∗ ∗	−0.07	0.15	−0.14	0.9
		(−0.78)	(7.55)	(−0.27)	(0.92)	(−1.67)	
Other MSCI firms	01/1998-04/2009	0.10 ∗ ∗	0.99 ∗ ∗	−0.21 ∗ ∗	−0.02	−0.01	0.99
		(2.01)	(54.91)	(−8.81)	(−1.48)	(−0.57)	
	01/1998-08/2001	0.36 ∗ ∗	0.89 ∗ ∗	−0.27 ∗ ∗	−0.13 ∗ ∗	−0.01	0.99
		(3.89)	(21.24)	(−15.20)	(−4.51)	(−0.72)	
	09/2001-08/2005	0.02	0.99 ∗ ∗	−0.14 ∗ ∗	−0.03∗	−0.01	0.99
		(0.40)	(80.04)	(−4.52)	(−1.73)	(−1.12)	
	09/2005-04/2009	−0.04	1.00 ∗ ∗	−0.11 ∗ ∗	−0.01	0.02 ∗ ∗	1.00
		(−0.58)	(41.50)	(−2.47)	(−0.28)	(2.11)	
Long-short: MSCI firms	01/1998-04/2009	−0.28	−0.03	0.02	0.00	−0.05	−0.02
		(−1.09)	(−0.42)	(0.29)	(0.03)	(−0.79)	
	01/1998-08/2001	−0.42	0.18	0.21∗	0.22	−0.06	−0.01
		(−0.65)	(1.02)	(1.99)	(1.13)	(−0.93)	
	09/2001-08/2005	0.32	0.09	−0.50 ∗ ∗	−0.37 ∗ ∗	0.14 ∗ ∗	0.35
		(0.81)	(1.30)	(−3.42)	(−3.07)	(2.25)	
	09/2005-04/2009	−0.20	−0.15	0.04	0.16	−0.16∗	0.11
		(−0.57)	(−1.12)	(0.15)	(0.81)	(−1.78)	

* (**, ***) means that the appropriate parameter is different from zero at the 10% (5%, 1%) significance level, respectively.

Values in () are the robust z-statistic.

Table A4.9: Parameter estimates for the European stock market in four-factor models for different portfolios and time periods

	Time period	Alpha	$r_{mt} - r_{it}$	SMB_t	HML_t	WML_t	R^2
Sustainability leaders	01/1998-04/2009	−0.11	0.81 ∗ ∗∗	−0.52 ∗ ∗∗	0.01	−0.20 ∗ ∗	0.77
		(−0.36)	(9.43)	(−3.59)	(0.06)	(−2.31)	
	01/1998-08/2001	−0.13	0.48 ∗ ∗∗	−0.79 ∗ ∗∗	−0.38 ∗ ∗	−0.03	0.64
		(−0.19)	(6.84)	(−3.85)	(−2.17)	(−0.30)	
	09/2001-08/2005	−0.15	0.82 ∗ ∗∗	−0.65 ∗ ∗∗	−0.03	−0.10	0.77
		(−0.30)	(8.38)	(−5.19)	(−0.13)	(−0.62)	
	09/2005-04/2009	0.30	0.94 ∗ ∗∗	−0.40 ∗ ∗	0.36	−0.36 ∗ ∗	0.91
		(0.84)	(12.81)	(−2.34)	(1.00)	(−2.48)	
MSCI sustainability leaders'	01/1998-04/2009	−0.04	0.81 ∗ ∗∗	−0.50 ∗ ∗∗	−0.05	−0.17∗	0.77
		(−0.13)	(9.68)	(−3.40)	(−0.38)	(−1.93)	
	01/1998-08/2001	0.10	0.50 ∗ ∗∗	−0.70 ∗ ∗∗	−0.39 ∗ ∗∗	0.03	0.66
		(0.17)	(8.00)	(−3.25)	(−2.85)	(0.28)	
	09/2001-08/2005	−0.02	0.78 ∗ ∗∗	−0.69 ∗ ∗∗	−0.08	−0.10	0.76
		(−0.05)	(8.07)	(−5.14)	(−0.37)	(−0.62)	
	09/2005-04/2009	0.28	0.94 ∗ ∗∗	−0.42 ∗ ∗	0.25	−0.36 ∗ ∗	0.91
		(0.80)	(13.47)	(−2.54)	(0.68)	(−2.54)	
Other MSCI firms	01/1998-04/2009	0.23	0.85 ∗ ∗∗	−0.44 ∗ ∗∗	0.05	−0.11∗	0.84
		(0.93)	(13.14)	(−3.66)	(0.51)	(−1.66)	
	01/1998-08/2001	0.20	0.66 ∗ ∗∗	−0.44 ∗ ∗	−0.22 ∗ ∗	−0.11	0.83
		(0.45)	(13.18)	(−2.59)	(−2.08)	(−1.42)	
	09/2001-08/2005	0.39	0.80 ∗ ∗∗	−0.55 ∗ ∗∗	0.00	−0.03	0.79
		(0.89)	(10.20)	(−3.82)	(0.01)	(−0.26)	
	09/2005-04/2009	0.46	0.99 ∗ ∗∗	−0.65 ∗ ∗∗	0.31	−0.09	0.92
		(1.26)	(10.26)	(−4.86)	(0.85)	(−0.69)	
Long-short: MSCI firms	01/1998-04/2009	−0.26	−0.04	−0.07	−0.10	−0.06	0.00
		(−1.61)	(−1.15)	(−0.84)	(−1.10)	(−1.01)	
	01/1998-08/2001	−0.10	−0.16 ∗ ∗∗	−0.26 ∗ ∗	−0.17	0.14	0.05
		(−0.27)	(−2.71)	(−2.10)	(−1.32)	(1.45)	
	09/2001-08/2005	−0.41	−0.03	−0.14	−0.08	−0.08	0.01
		(−1.46)	(−0.39)	(−0.92)	(−0.62)	(−0.95)	
	09/2005-04/2009	−0.18	−0.05	0.23 ∗ ∗	−0.06	−0.26 ∗ ∗	0.12
		(−0.63)	(−0.95)	(2.17)	(−0.16)	(−2.18)	

* (**, ***) means that the appropriate parameter is different from zero at the 10% (5%, 1%) significance level, respectively.

Values in () are the robust z-statistic.

Table A4.10: Parameter estimates for the US stock market in four-factor models for different portfolios and time periods, no financial firms

	Time period	Alpha	$r_{mt} - r_{it}$	SMB_t	HML_t	WML_t	R^2
Sustainability leaders	01/1998-04/2009	0.00	0.86 * **	−0.17*	−0.21 * **	−0.05	0.74
		(0.00)	(13.24)	(−1.76)	(−2.98)	(−0.92)	
	01/1998-08/2001	0.09	0.92 * **	−0.03	−0.08	−0.09	0.61
		(0.13)	(4.72)	(−0.22)	(−0.38)	(−1.36)	
	09/2001-08/2005	0.33	1.14 * **	−0.61 * **	−0.48 * **	0.15*	0.87
		(0.92)	(19.95)	(−4.96)	(−4.49)	(1.86)	
	09/2005-04/2009	−0.05	0.79 * **	0.06	−0.19 * *	−0.06	0.89
		(−0.19)	(8.22)	(0.30)	(−2.11)	(−0.68)	
MSCI sustainability leaders'	01/1998-04/2009	−0.02	0.89 * **	−0.20 * *	−0.19 * *	−0.04	0.73
		(−0.07)	(13.48)	(−2.20)	(−2.58)	(−0.71)	
	01/1998-08/2001	0.15	0.94 * **	−0.05	−0.06	−0.09	0.60
		(0.22)	(4.55)	(−0.35)	(−0.27)	(−1.37)	
	09/2001-08/2005	0.33	1.20 * **	−0.70 * **	−0.51 * **	0.17*	0.85
		(0.89)	(18.92)	(−5.32)	(−4.80)	(1.87)	
	09/2005-04/2009	−0.07	0.83 * **	0.03	−0.14	−0.03	0.89
		(−0.25)	(8.04)	(0.12)	(−1.58)	(−0.35)	
Other MSCI firms	01/1998-04/2009	0.18 * **	0.95 * **	−0.19 * **	−0.16 * **	−0.01	0.97
		(2.83)	(40.36)	(−6.84)	(−9.85)	(−0.35)	
	01/1998-08/2001	0.48 * **	0.81 * **	−0.23 * **	−0.28 * **	−0.03	0.97
		(4.34)	(21.11)	(−7.57)	(−8.56)	(−1.68)	
	09/2001-08/2005	0.04	0.98 * **	−0.17 * **	−0.05	−0.02	0.98
		(0.50)	(43.06)	(−4.37)	(−1.59)	(−1.23)	
	09/2005-04/2009	0.02	0.99 * **	−0.05	−0.22 * **	0.05 * **	0.99
		(0.27)	(31.92)	(−0.90)	(−4.35)	(2.80)	
Long-short: MSCI firms	01/1998-04/2009	−0.19	−0.05	−0.01	−0.04	−0.04	−0.02
		(−0.73)	(−0.79)	(−0.17)	(−0.48)	(−0.64)	
	01/1998-08/2001	−0.32	0.13	0.18	0.22	−0.06	−0.04
		(−0.47)	(0.65)	(1.50)	(1.00)	(−1.01)	
	09/2001-08/2005	0.29	0.22 * **	−0.53 * **	−0.46 * **	0.20 * *	0.31
		(0.68)	(3.23)	(−3.26)	(−3.70)	(2.07)	
	09/2005-04/2009	−0.10	−0.16	0.08	0.08	−0.08	0.03
		(−0.29)	(−1.22)	(0.30)	(0.59)	(−0.93)	

Table A4.11: Parameter estimates for the European stock market in four-factor models for different portfolios and time periods, no financial firms

	Time period	Alpha	$r_{mt} - r_{it}$	SMB_t	HML_t	WML_t	R^2
Sustainability leaders	01/1998-04/2009	0.05	$0.69 * **$	$-0.46 * **$	$-0.34 * *$	-0.10	0.67
		(0.16)	(6.56)	(−2.74)	(−2.50)	(−1.00)	
	01/1998-08/2001	−0.10	$0.33 * *$	$-0.73 * **$	$-0.75 * **$	0.02	0.54
		(−0.13)	(2.61)	(−3.15)	(−3.46)	(0.11)	
	09/2001-08/2005	0.29	$0.71 * **$	$-0.47 * **$	$-0.62 * **$	0.04	0.69
		(0.61)	(7.13)	(−3.43)	(−3.78)	(0.25)	
	09/2005-04/2009	0.44	$0.91 * **$	$-0.50 * **$	−0.09	−0.17	0.89
		(1.34)	(11.65)	(−2.85)	(−0.25)	(−1.24)	
MSCI sustainability leaders	01/1998-04/2009	0.13	$0.70 * **$	$-0.42 * *$	$-0.44 * **$	−0.06	0.67
		(0.44)	(6.46)	(−2.33)	(−3.62)	(−0.55)	
	01/1998-08/2001	0.10	$0.35 * **$	$-0.58 * *$	$-0.79 * **$	0.15	0.56
		(0.16)	(2.92)	(−2.42)	(−5.43)	(0.87)	
	09/2001-08/2005	0.38	$0.68 * **$	$-0.52 * **$	$-0.68 * **$	0.04	0.67
		(0.81)	(7.03)	(−3.82)	(−3.84)	(0.25)	
	09/2005-04/2009	0.45	$0.90 * **$	$-0.53 * **$	−0.11	−0.16	0.88
		(1.38)	(11.92)	(−3.02)	(−0.30)	(−1.22)	
Other MSCI firms	01/1998-04/2009	0.29	$0.79 * **$	$-0.36 * **$	−0.07	−0.07	0.80
		(1.17)	(10.97)	(−2.76)	(−0.83)	(−0.90)	
	01/1998-08/2001	0.24	$0.61 * **$	−0.33∗	$-0.32 * *$	−0.10	0.78
		(0.56)	(7.66)	(−1.84)	(−2.68)	(−0.93)	
	09/2001-08/2005	0.43	$0.77 * **$	$-0.45 * **$	−0.17	0.02	0.78
		(1.08)	(10.55)	(−3.41)	(−0.92)	(0.20)	
	09/2005-04/2009	0.51	$0.97 * **$	$-0.66 * **$	0.05	0.05	0.87
		(1.21)	(8.34)	(−4.21)	(0.10)	(0.37)	
Long-short: MSCI firms	01/1998-04/2009	−0.16	−0.08∗	−0.06	$-0.37 * **$	0.01	0.08
		(−0.90)	(−1.82)	(−0.63)	(−3.73)	(0.14)	
	01/1998-08/2001	−0.14	$-0.26 * **$	−0.25∗	$-0.47 * **$	0.25	0.16
		(−0.34)	(−3.84)	(−1.90)	(−3.93)	(1.66)	
	09/2001-08/2005	−0.05	−0.09	−0.07	$-0.51 * **$	0.02	0.09
		(−0.15)	(−1.31)	(−0.44)	(−2.99)	(0.26)	
	09/2005-04/2009	−0.06	−0.07	0.13	−0.16	−0.22∗	0.06
		(−0.20)	(−1.12)	(1.24)	(−0.36)	(−1.88)	

Chapter 5

Strategic sustainability and financial performance: Exploring abnormal returns*

Abstract

The ongoing empirical debate about whether SRI is associated, if anything, with subpar or surpassing financial performance is characterized by a somewhat indistinct focus and the infeasibility of tapping the full potential of existing models. By indistinct focus we mean an analysis based on an aggregation of a myriad of SRI factors that potentially affect a firm's financial performance. The inability of taking full advantage of existing models is reflected by the fact that studies with European data have not been able to comprehensively account for systematic risk tilts. This paper presents a portfolio analysis that overcomes these issues by analyzing a distinct selection of small and innovative firms. We argue that both their strategic implementation of Corporate Social Responsibility and the general growth in Socially Responsible Investments (SRI) lend themselves to an explanation for positive abnormal returns of this portfolio. We account for the idiosyncratic invest-

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ment style of SRI by introducing a comprehensive pan-European risk-adjusted portfolio analysis based on the Carhart four-factor model. A novel propensity score matching method in conjunction with the estimation of structural models completes the conventional robustness checks in the literature.

5.1 Introduction

Despite the recent economic crises, socially responsible investing (SRI) has been strikingly resilient and not merely a caprice of prosperous economic times. SRI describes an investment strategy that accounts for environmental, social, and governance factors (ESG). Particularly in Europe, its expansion in the last decade has been impressive: Whereas in 2002, the European Sustainable Investment Forum reported 34 Bio € invested in so-called core SRI, for 2009 the same organization documented investments of 1'200 Bio € (Eurosif, 2010, 2003). This reflects an annual growth rate of more than 66%. The Sustainable Investment Forum for Germany, Austria, and Switzerland estimates that from 2005 to 2009, SRI assets in mutual funds, mandates, and other financial products have increased by roughly 29 percent per year (FNG, 2011). In comparison, for the mature US market, the Forum for Sustainable and Responsible Investment points out a 2.5% increase in total assets managed under policies that incorporate ESG criteria from 2001-2010, from 2'010 Bio to 2'512 Bio US Dollars. This stands in contrast to US data from 1993-2001, when the same growth rate amounted to 43% (US-Sif, 2010). Even discounting the fact that a fair amount of the worldwide growth is attributable to bond investments and increasing asset coverage, it is fair to assume that in Europe, SRI in equities has grown substantially in the last decade, highlighting the economic importance for a systematic understanding of the financial ramifications that SRI entails.

But how might SRI affect the financial performance of a firm? Although conventional economic theory would roughly point to a negative association (Friedman, 1970), recent and more pertinent descriptions of the phenomena give reason to believe that there is something to be gained by SRI. Due to its roots in principal-agent-theory, corporate governance is likely the most established theoretical branch in this regard. The significance of corporate governance in the context of shareholder and stakeholder value is discussed

thoroughly by Tirole (2001). Although the concept of stakeholder value - a concept which incorporates many ESG factors - fares worse than shareholder value on many levels (such as fuzzy tasking), it has conceptual advantages as well. Biased decision-making in presence of negative externalities, for instance, makes for one of the unintentional consequences of shareholder value. From a more technical perspective, SRI has been associated with a lack of optimal portfolio diversification for investors. Any restriction to the market portfolio is said to edge away from the efficient frontier. Yet Moskowitz (1972) counters that markets might fail to price value-relevant ESG factors, leading to higher abnormal returns for corresponding firms. In a seminal paper, Merton (1987) presents an asymmetric information model in which investors overlook certain stocks. The smaller investor base is associated with suboptimal risk sharing, yielding positive abnormal returns for the stocks in question. In the next section, we take up this theoretical discussion; but ultimately, the question of whether SRI affects firm performance negatively or positively remains an empirical one.

There is an established literature examining the empirical effect of SRI on financial performance. Three methodologically distinct branches have evolved: Regression analyses, event studies, and portfolio analyses. Formerly a frequently used approach, simple regression analyses examine long-term effects of ESG factors on financial performance. They are, however, prone to omitted variable bias and reverse causality. Ambec and Lanoie (2007) summarize the results of nine such studies and conclude that there is limited evidence for a relationship.

In contrast, event studies mitigate the aforementioned caveats by focusing on a narrow time frame around an unexpected incident, say, an oil spill or employment layoffs. This firm-specific announcement is assumed to force a sudden reassessment of the firm's value on the part of its investors. In calculating abnormal returns within the specified time frame, significant market reactions to the announcement can be deduced. Many studies indicate substantial impacts on firm value from such incidents (Hamilton, 1995; Dasgupta

et al., 2001; Karpoff et al., 2005; Capelle-Blancard and Laguna, 2010; Linn, 2010). Although causally instructive, it remains unclear whether the observed market reactions have a lasting effect on firm value and why positive incidents often fail to show an impact.

Portfolio analyses, on the other hand, rely on a classic finance model in order to calculate a fund's long-term performance. Based on the capital asset pricing model (CAPM), the approach compares the abnormal returns of SRI funds with appropriate benchmarks. Of the three research branches, portfolio analyses currently constitute the most active one. Most studies gather data from actively managed SRI funds (see for a comprehensive overview Derwall et al., 2011). So far, the empirical results are somewhat mixed, but, at least for the US, lean towards one direction. Hardly any of the studies indicate that SRI results in significant underperformance of the corresponding funds. Most studies cannot reject the assumption of equal performance. Indeed, some studies suggest that SRI funds fare better than the market.

Although increasingly sophisticated, the current batch of portfolio analyses reveals some drawbacks of its own. By arbitrarily lumping together SRI funds that cater to different ESG priorities, specific ESG factors that are linked to financial performance are bound to drown in the aggregate of a myriad of non-relevant factors. In addition, the analysis of actively managed funds might distort the effect of the specific ESG factors by virtue of the portfolio managers' skills, transaction costs, or in- and outflows of assets. Most importantly, many studies disregard the risk tilts that are associated with the idiosyncratic investment style of SRI. It has been repeatedly shown that the risk factors introduced by Fama and French (1993) and Carhart (1997) explain substantial amounts of abnormal SRI fund returns (Bauer et al., 2005; Derwall et al., 2005; Bauer et al., 2007). Neglecting these factors bears the risk of false conclusions with respect to the effect of ESG factors on financial performance.

As yet, there have only been comprehensive data on US risk factors, which partly explains the heavy US focus of the literature. However, there are good

reasons to extend the field of research to Europe. Whereas in the US, the SRI market has evolved and expanded in the past decades and has settled somewhat by now, Europe is currently catching up (Bauer et al., 2005). Striking growth rates support this view. We argue that these demand shifts might be key in explaining abnormal financial performance. Europe and the US differ in other relevant aspects as well. Cortez et al. (2012) stress that there are geographical differences in the investment style of socially responsible funds. Data on market interest in nonfinancial information are consistent with such distinct priorities. Eccles et al. (2011b) show that US investors reveal a pronounced interest in governance data, while European investors are disproportionately keen on environmental data. This seems partly explainable by the fundamental differences in jurisdictions and political agendas. Lundgren and Olsson (2010) provide an example for different market reactions between the US and Europe using an event study: In Europe, environmental incidents are associated with a loss of value for the firm in question, while results are not statistically significant for US firms. Last but not least, extending the focus to European data meets the unanimous advice for out-of-sample evidence (Bauer et al., 2007; Derwall et al., 2005, 2011).

This paper investigates how a distinct selection of small European growth SRI firms fares in comparison to the market. In doing so, our portfolio analysis follows up the existing branch of studies and contributes to the literature by addressing the aforementioned problems along four dimensions.

First, we circumvent the distortion of an active portfolio management and the problem of an indistinct focus of aggregated funds by analyzing specialized firms selected by the sustainability research of the Zurich Cantonal Bank (ZKB). These firms, mainly small growth stocks with a focus on strategic Corporate Social Responsibility (CSR) innovation, constitute a ZKB internal universe from which the portfolio managers can pick. We treat this pool as a synthetic portfolio and compare it to the market.

In our second contribution, we introduce an exhaustive risk-adjusted portfolio analysis with European data. Comprehensive pan-European risk factors,

constructed by Schmidt et al. (2011), have enabled this application study and account for the risk tilts that are rooted in the specific investment style of our SRI portfolio.

Third, in addition to the established errors-in-expectations argument for the explanation of positive abnormal returns, we discuss an overlooked structural argument based on rising demand in the SRI market. Finally, our results prompted us to go one step further and check the robustness of our estimates in new ways. Using a propensity score matching method, we match our portfolio annually to all the firms in the market and construct control portfolios with highly similar characteristics in terms of size, book-to-market value, and momentum; key figures upon which the risk factors are based. In addition, we account for country of origin and industry. To our knowledge, this method has never been applied in a portfolio study in combination with asset pricing models, introducing a novel technique to the existing literature.

We find a robust financial outperformance for the analyzed portfolio across different scenarios. In terms of the Carhart four-factor model, the monthly outperformance amounts to 1.3%. Although there is reason to believe that some model misspecification is present due to the portfolio's tilt towards small and medium sized growth firms, the outperformance is reduced at most to 1% when adjusting for this issue. The rest of this paper is structured as follows. The next section (5.2) discusses our hypothesis that addresses the relationship between SRI and financial performance. In Section 5.3, we lay out the methodology of the asset pricing models and the data that are used for the hypothesis tests in Section 5.4.[1] Robustness of the analysis is dealt with in Section 5.5 using the matching method. Section 5.6 concludes.

[1]Some preliminary results of this paper were published in a leaflet of the Zurich Cantonal Bank (2011).

5.2 SRI and financial performance

This section presents two distinct arguments that explain why our SRI portfolio might exhibit abnormal returns. First, the small growth firms distinguish themselves strategically based on their innovative approach in tackling sustainable solutions to societal problems. In contrast to conventional, more universal CSR classifications, we argue that our portfolio rather fits the notion of so-called strategic CSR. The relationship between generic SRIs and financial performance has been studied widely. Newer evidence indicates that this attention might have dispelled any errors in expectations by the market (Bebchuk et al., 2013; Derwall et al., 2011). We are thus more likely to find these mispricings in the specialized strategic CSR niche of our portfolio. The second argument relates to the influence of the rapidly rising market share of SRI on stock prices. Positive screening could lead to market disequilibrium accompanied by positive abnormal returns. Although both arguments can be characterized by market imperfections, they tackle the issue from different angles. The reasoning gives rise to our hypothesis and testable implications, which are the subject of the next sections.

Economists have traditionally been wary about the proposition that socially benevolent investments are financially beneficial for firms. A prevailing objection is the incompatibility with the objective of profit maximization, claiming that diverting resources from this goal for CSR reasons is bound to make a firm worse off (Friedman, 1970). Even if CSR were to have any value-relevance, firms would have adopted it long ago. The premise is that if market participants could act more efficiently by adjusting their actions, they would do so by assumption. But evidently, not all choices are optimal in the first place, for we observe how companies keep finding new ways to raise their competitiveness by lowering costs and expanding market shares in innovative ways. Though often associated with a constraint, there is reason to believe that CSR can be used strategically to such ends as well. Recent economic

frameworks suggest that there does exist a financial case for so-called strategic CSR.

The seminal publications of McWilliams and Siegel (2001) and Baron (2001), both of whom originally coined the term strategic CSR, stress the role of product differentiation in this context. In line with the predictions of strategic CSR, Siegel and Vitaliano (2007) show that firms selling experience goods are more likely to engage in CSR for strategic reasons. Bagnoli and Watts (2003) define CSR as the private provision of a public good and present a model in which firms compete for socially responsible consumers. Besley and Ghatak (2007) pick up on this definition and discuss potential advantages of CSR as a provision of public goods. A prominent summary of the theoretical strategic CSR literature has been brought forward by Porter and Kramer (2006, 2011). They subsume the concept of strategic CSR and dub it shared value, "policies and operating practices that enhance the competitiveness of a company while simultaneously advancing the economic and social conditions in the communities in which it operates" (Porter and Kramer, 2011, p.67).In a nutshell, shared value or strategic CSR is both beneficial for the firm and the community it operates in. Strategic CSR involves a break from the commonly defensive and naive application of CSR. According to Porter and Kramer, by and large companies have made use of CSR as a preemptive or a mitigating shield that protects them from potential accusations concerning their business practice when, in reality, they should focus on the interdependence of business and society. To this end, it is proposed that companies incorporate aspects of CSR in a non-fragmented, targeted way as to establish a business strategy. So instead of addressing every possible justifiable CSR concern, a company should analyze its competitive landscape and its strengths and weaknesses that overlap with specific CSR aspects. On this basis, it should employ its comparative advantage to create a unique position that distinguishes it from the rest of the market. In this sense, strategic CSR is in line with the traditional economic argument of profit maximization as the firm's objective.

To the casual observer, strategic CSR can be mistaken for generic CSR

as they share the same toolbox. But instead of applying these tools loosely at different market frontiers, strategic CSR integrates them into a coherent business strategy. In order to differentiate between the generic and strategic CSR, one needs to be both knowledgeable about a firm's strategy as a whole and the economic advantages that strategic CSR entails in that case. This is no easy task, in particular because the concept has merely begun to take root. Unlike generic CSR, strategic CSR cannot (yet) easily be extracted from ESG data but requires skilled expertise, entailing considerable costs. In turn, these costs put into perspective any financial market advantage resulting from such research.

The incorporation of potentially value-relevant information from strategic CSR is thus likely to take some time. This argument is supported by the fact that recently, some CSR studies have failed to find the superior risk-adjusted returns they used to. For example, Derwall et al. (2011) show that in the United States the positive abnormal returns of firms with a high score in employee relations as measured by Kinder, Lydenberg, and Domini (KLD) diminish over time.[2] Derwall et al. argue that any errors in investors' expectations regarding value-relevant information of CSR are bound to be temporary as the market moves along its learning curve. Indeed, incorporation of CSR information, not only in form of KLD scores, has become ubiquitous among investors (Eccles et al., 2011b). Consequently, any value-relevant information that generic CSR potentially used to proxy for would likely have been arbitraged by now, accounting for the disappearance of positive abnormal returns. By the same token, formerly positive abnormal returns from good corporate governance seem to have vanished. The widely cited governance-based investment strategy put forth by Gompers et al. (2003) and modified by Bebchuk and Hamdani (2009) show how the US market apparently failed to correctly price so-called "entrenching" governance provisions in the 1990s. However, the superior returns from holding firms with few such provisions (and short-

[2]In the empirical SRI literature, the KLD rating is an established proxy for the measurement of various dimensions of CSR for a selection of firms.

ing the ones with many) have disappeared. In a follow-up paper, Bebchuk et al. (2013) show that during the 2000s any abnormal returns ceased to exist with respect to good governance. Like Derwall et al. (2011), Bebchuk et al. (2013) attribute this disappearance to a mispricing that has disappeared once markets have learned how to price these provisions correctly. Bebchuk et al. underpin this argument by showing that during the 1990s corporate governance was associated with fundamental firm differences in drivers of corporate performance: Until the 2000s (stock) market analysts were more positively surprised by the earnings announcements of well governed firms than by those of poorly governed ones, producing positive abnormal returns in the amount of 69 basis points from 1990-1999. The disappearance of abnormal returns in 2000-2008 coincided with increased attention to corporate governance by the media and market participants. In both Derwall et al. and Bebchuk et al., markets have eventually adjusted to a pricing equilibrium; not instantly but gradually over time.

To sum up the errors-in-expectations argument, given the present state of ESG data, strategic CSR seems more difficult to identify than generic CSR. On the other hand, economic theory suggests that strategic CSR potentially harbors value-relevant information, information that the market might have yet to incorporate.

In addition to investors' errors in expectations, there is a complementary argument that can explain positive abnormal returns. Given plausible assumptions, it turns out that rising demand in SRI can affect abnormal returns. In empirical studies based on stock market data, an outperformance could stem from two sources. Better than expected fundamentals of companies (and the ensuing stronger stock demand of investors) on the one hand, and rising stock demand without changes in the companies' cash flows on the other hand. Both effects lead to higher stock prices.

Relating to the latter effect, particularly in Europe managed assets following SRI strategies have grown considerably in the last decade. It can be argued that this growth itself has affected stock prices positively.

Like any active investment strategy, SRI assumes that rational asset pricing models do not capture all relevant factors. After all, it is the aim of these strategies to outperform the market. Under rational asset pricing models, investors should simply buy stocks according to their current market weights. Some SRI investors, however, will deviate from current market weights of stocks for financial reasons. They will overweight certain stocks if they observe attractive SRI features that proxy for overlooked value-relevance and conversely will underweight stocks that they deem to be too expensive in this regard. As a consequence, SRI investment will have an impact on stock prices and investments of firms if demand and supply curves are not fully elastic (Wall, 1995). This could happen if rational pricing models have not captured all relevant factors or if not all market participants invest accordingly. Following this argument, Petajisto (2009) puts forth a model in which CAPM investors, active managers (such as SRI followers), and noise traders can coexist in equilibrium. The effect of rising SRI demand is more pronounced if the supply of stocks is less elastic. Stocks with a high market capitalization enjoy higher analyst coverage and larger institutional ownership. It is therefore plausible to assume that the supply of large capitalization stocks is more elastic than the supply of small capitalization stocks. From this perspective, our portfolio of small growth stocks portrays a pronounced case of a relatively inelastic supply. Following this argument, rising demand from SRI investors will affect stock prices of these companies all the more, leading to a financial outperformance in form of positive abnormal returns.

There is a body of empirical papers which are consistent with this argument. They analyze SRI performance in the US, where growth in SRI assets was particularly strong in the 1990s. In general, most of these studies find that risk-adjusted SRI returns are comparable to those of conventional benchmarks. There are some studies, though, which present a positive relation between certain CSR criteria and financial performance. Derwall et al. (2005) show that a portfolio scoring high on eco-efficiency criteria outperforms a portfolio of low scoring firms by 3.3% per year from 1995-2003. Kempf and

Osthoff (2007b) find that a portfolio with high social responsibility ratings from KLD outperforms a portfolio with low scores by up to 8.7% per year over the period from 1992-2004. Eccles et al. (2011a) use a matched sample of 180 companies and document that, from 1993-2010, a portfolio of high sustainability companies reveals an annual abnormal performance of 4.8% compared to a portfolio of low sustainability companies. And most recently, Derwall et al. (2011) find that a portfolio of positively screened stocks, highly rated on employee-relations, earned positive abnormal returns of 5.6% per year from 1992-2002. The exponential growth of SRI assets in Europe in the last decade coincides with our empirical time frame, which is indicative that rising demand might have affected financial performance.

Taken together, we identify two channels through which positive abnormal returns can emerge. Strategic CSR can contain value-relevant information, which due to errors in investors' expectations can lead to positive abnormal returns in the respective stocks. Complementary, rising demand in SRI can produce positive abnormal returns brought about by market frictions. These two arguments motivate our hypothesis that particularly in times of rising demand, small and strategic CSR stocks are positively associated with financial performance, a hypothesis we empirically test for in the next sections.

5.3 Data and methodology

Innovation acts as one particular channel of strategic CSR. Product and process innovation require foresight, assessments about future market dynamics, and likely considerable investments in the present. The focus is not on short-term profit maximization but on long-term growth, all features commonly associated with sustainability. With this notion, the sustainability research team of ZKB identifies small and middle capitalized firms offering innovative products and services. We henceforth refer to this portfolio as "innovators". These innovators emphasize sustainable solutions from a societal point of view against the backdrop of climate change and the demographic trend of

ageing. The firms can be allocated to the following six domains: renewable energy, energy efficiency, mobility, natural resources, health, and education. We conjecture that the innovators fit both the strategic CSR argument and the rising demand argument.

Table A5.3 in the appendix reports the number of firms in the innovator portfolio and the average annual market value compared to our entire universe of European firms. Apart from the years 2006 and 2007, the average size of an innovator is roughly half the market value of the average European firm included in the Thomson Reuters Datastream and Thomson Reuters Worldscope database. The number of innovators increases from 16 firms in 2002 to 77 firms in 2009. The portfolio shows a distinct tilt towards the industrial sector in general and towards energy related industries in particular, with the services sector playing only a minor role. According to the International Classification Benchmark (ICB), Table A5.4 shows that about two thirds of the 290 firms operate in the "Oil & Gas" and "Industrials" industry, 42 in utilities, 17 in the technology industry, and 16 in basic materials. This highlights that the innovator portfolio is tilted towards certain industries. A look at industry subsector levels in Table A5.5 reveals that roughly a third of the innovators deals with renewable energy equipment, followed by clusters geared towards industrial machinery, alternative electricity, alternative fuels, and building materials and fixtures. Table A5.6 presents the distribution of firm-year observations across the European countries. German firms constitute roughly 60 percent of the portfolio. We address both sector and country bias in our robustness checks in Section 5.

It is worth pointing out again that this selection of firms constitutes a synthetic portfolio, and not an actively managed one. By virtue of this synthetic construction, we avoid issues of performance distortions such as portfolio manager skills or in- and outflows, which are generally unavoidable when analyzing performances of (sustainability) funds.[3]

[3]Transaction costs such as commissions, bid/ask spreads, and market impact influence fund performance as well. For that reason, transaction costs are often considered in the

In the heyday of the CAPM, value weighting would have been the obvious answer to the question which weighting scheme to apply to our portfolio. But ever since the empirical shortcomings of the CAPM became known, other weighting schemes such as Bayesian approaches to estimation error, methods of moment restrictions, portfolio constraints, optimal combinations of portfolios, or equal weighting merit consideration as well. After evaluating 14 models in seven empirical datasets, (DeMiguel et al., 2009, p. 1948) come to the conclusion that the equal weighting 1/N portfolio strategy (which they dub "naive diversification") "should serve at least as a first obvious benchmark". In order to reduce the influence of idiosyncratic risk in combination with firm heterogeneity in terms of size, we have therefore opted for the equal weighting method as our base case for both the innovator and the control portfolios.[4]

In order to assess how the innovators perform, we build a synthetic portfolio. For the appraisal of the performance of both the innovator and the control portfolios, which we construct in our robustness checks in Section 5, we employ pan-European risk factors of the standard four-factor capital asset pricing model based on Carhart (1997) as control variables. These risk factors have only recently been calculated by a group of researchers of the Universities of Aarhus and Zurich and ETH of Zurich (Schmidt et al., 2011).[5] Thomson Reuters Datastream and Thomson Reuters Worldscope are the underlying databases for the calculation of these factors. The dataset consists of 43'005 European firms for the period of 1980 to April 2009. Both static

practical implementation of theoretical investment strategies in synthetic portfolios. In our case, the inclusion of transaction costs would somewhat reduce absolute and abnormal returns, but only marginally as 82% of the firms remain in the synthetic portfolio until 2009. Therefore, this strategy would have a low turnover and negligible transaction costs.

[4]Calculations of value weighted portfolios tend to yield similar results and are available from the authors upon request.

[5]By now, these factors also form part of the basis in the analysis of Mollet and Ziegler (2012), who investigate the performance of firms with high market values in the US and Europe.

and dynamic screens as well as numerous other quality checks reduced the number of firms available to 11'054 for the calculation of the market return, 9'462 for the calculation of the returns for size and value, and 10'035 for the calculation of the momentum factor, respectively. All financial data were converted into US dollars. For values before 2002, a fixed euro conversion rate was applied. Other currencies were converted via the at that time current exchange rate. The resulting database for the factors size, value, momentum, and the market encompasses the period from January 1985 to April 2009. Since its introduction, a wide range of empirical studies have shown that the one-factor model based on the market model (Sharpe, 1964) and the CAPM (Markowitz, 1952) describe the cross section of stock returns insufficiently. In particular, small and value stocks reveal systematically diverging stock returns which cannot be predicted by the market model. Based on the evidence of these "anomalies", Fama and French (1993) advocate a three-factor model, which, in addition to the excess return of the market, adds two factors that proxy for size and value. Jegadeesh and Titman (1993) add to this insight. They show that stocks which have performed exceptionally well during the last twelve months tend to continue doing so in the next few months. Carhart (1997) incorporates this additional momentum factor into Fama and French's three-factor model. This four-factor model has proven to be better in terms of explanatory power of cross sectional stock returns and is now the most commonly used asset pricing model in financial economics.

$$r_{it} - r_{ft} = \alpha_i + \beta_{i1}(r_{mt} - r_{ft}) + \beta_{i2}SMB_t + \beta_{i3}HML_t + \beta_{i4}WML_t + \epsilon_{it} \qquad (5.1)$$

Equation 5.1 formalizes the four-factor model. The excess return of a stock is decomposed on the basis of the four aforementioned factors market, size (SMB), value (HML), and momentum (WML). r_{it} stands for the return of a given stock portfolio in month t, r_{ft} is the return of the risk free asset (in our

case, the euro 1-month libor rate), and r_{mt} is the return of the pan-European market. The return series for the factor SMB_t is the difference between the returns of portfolios consisting of stocks with low market capitalization and portfolios consisting of stocks with high market capitalization. The return series for HML_t is the difference between the returns of portfolios consisting of stocks with a high book-to-market ratio and portfolios consisting of stocks with a low book-to-market equity ratio. Finally, the return series for the momentum factor WML_t is the return difference between a portfolio of past winners and a portfolio of past losers. The application of the four-factor model yields estimates for the coefficients β_{i1}, β_{i2}, β_{i3}, β_{i4}, and α_i. The coefficients β_{i1}, β_{i2}, β_{i3} and β_{i4} mirror the sensitivities of a given portfolio to the factors market risk, size, value, and momentum, ϵ_{it} stands for the error term, and α_i reflects the average periodical (positive or negative) abnormal performance which cannot be explained by the four factors.

5.4 Results

The average monthly market return over the entire portfolio time span from 1/2002 to 4/2009 amounts to 0.30% (Table A5.7). This average return over 88 months is 0.01 percentage points below the yield of the risk free rate. When partitioning the full time period into two equally long sub-periods, we see that the dismal market performance is attributable to the second sub-period covering 9/2005 to 4/2009. This sub-period captures the financial crisis triggered in 2007 and yields an average monthly market return of -0.78%, while the risk free rate manages to return 0.39%. On the other hand, in the first sub-period between 1/2002 and 8/2005, the market generated monthly returns of 1.37%, whereas the risk-free interest rate offered only 0.23%.

Focusing on the average monthly return of the innovators in Table A5.7, we observe that the yield of 0.74% is substantially higher than the market return and that this result is driven by the second sub-period, during which the innovators fared much better than the market. The risk factors offer a

more nuanced insight of this performance. WML indicates that winners from the previous months by far outperform recent losers in all time periods: The momentum strategy generates monthly returns exceeding 1% in all periods. The returns of the SMB and HML strategy, 0.41% and 0.55% respectively, are both explained by their strong performance in the first sub-period. In the second sub-period, these strategies were barely profitable. These observations are in line with the theoretical reasoning of SMB and HML. The second sub-period largely covers an economic recession. During these harsh times, small and value firms are said to perform worse. Small firms exhibit problems in raising capital, and value firms find themselves unable to substantially lower any running capital costs, something growth firms are apt to do. Unlike value firms, growth firms can postpone investment expenditures as they are more flexible. Table 5.1 reports the Carhart four-factor model regression results for the full time period and the two sub-periods. Within a given estimation window, the factor loadings are assumed to be fix even though they might change as portfolio composition, risk perceptions, and demanded risk premia are likely to vary through time. In this sense, the sub-periods serve as a rough first robustness check in terms of temporal dependence. Below, we implement a more sophisticated approach to this issue. In order to control for possible distortions in the covariance of the estimates due to heteroskedasticity or autocorrelation in the disturbance term, only robust heteroskedasticity- and autocorrelation-consistent z-statistics according to Newey and West (1987) are reported. In line with common practice (Greene, 2002), the error structure is assumed to be possibly autocorrelated up to three lags.[6]

Table 5.1 shows the parameter estimates of the Carhart four-factor model. The alpha of the equally weighted innovator portfolio is outperforming the value weighted market monthly by 1.30%, a return which is significant at the 5% level. In contrast to the descriptive analysis, this outperformance cannot be clearly attributed to a particular sub-period. Because the market

[6]Current practice specifies the number of lags to be approximately the fourth root of the number of time series observations.

Table 5.1: Parameter estimates and Z-statistics in the four-factor model for different time periods

	α	$rm_t - r_{it}$	SMB_t	HML_t	WML_t	R^2
01/2002-04/2009	1.30**	1.51***	0.35	-1.16**	-0.07	0.61
	(2.14)	(10.94)	(1.18)	(-2.37)	(-0.30)	
01/2002- 08/2005	1.25	1.32***	0.71**	-1.48**	-0.26	0.45
	(1.14)	(4.60)	(2.04)	(-2.12)	(-0.75)	
09/2005-04/2009	1.54	1.54***	0.22	0.59	0.15	0.74
	(1.66)	(9.01)	(0.66)	(0.60)	(0.56)	

* (**, ***) means that the parameter is different from zero at the 10% (5%, 1%) significance level, respectively. The parenthesis below the point estimates contain the z-statistic, corrected for heteroskedasticity and autocorrelation up to three lags.

beta is always larger than one, the innovator portfolio is magnifying market movements and is therefore exposed to a higher systematic risk.

The significant and positive SMB loading in the first period highlights that the innovator portfolio performs well due to its tilt towards small stocks. On the other hand, the HML factor captures a significant negative loading variation of the innovator portfolio return in the full time period. This is attributable to the first sub-period because the point estimate of the HML loading in the second sub-period is low and not significant. Recall that Table A5.7 indicates that value firms outperform growth firms during the first sub-period, driving the outperformance over the full time span. The innovator portfolio mainly consists of small growth companies and exhibits a significant exposure to the risk factors SMB and HML. The outperformance of small cap stocks in the first sub-period therefore added to the absolute return of the portfolio. The strong tilt towards growth stocks on the other hand reduced the absolute performance in first sub-period when value stocks had a good run. But the outperformance of the innovator portfolio in comparison to the European market - as displayed by the statistically significant

alpha of 1.30% per month - was achieved more or less continuously over the whole observation period. As we will see in the following section, the growth character of the innovator portfolio is also supported when comparing the book-to-market-equity ratios in Table A5.10.

The two sub-periods offer only a limited glimpse into the intertemporal changes in portfolio composition, risk perceptions, and demanded risk premia. Figure 5.1 gives a more differentiated view by plotting the coefficients of the four-factor model and their 95% confidence intervals for a moving window regression. The method uses the estimation technique from Table 5.1 and applies it to a rolling regression time window of 36 months. This window selection translates into 30 degrees of freedom in the model estimation. The first regression window covers 1/2002 to 12/2004. Its coefficients and confidence intervals are plotted at the end of this range. Subsequently, the plots are updated by moving the time window forward monthly.[7] This technique has the advantage of not relying on disjoint and arbitrary time periods and allows for flexibility and structural interruptions in the estimates. The rolling regression plot for the alpha illustrates that the point estimates of the intercept of the innovator portfolio remain positive throughout the observed time window. The previous analysis of the two sub-periods revealed that the positive alpha is not driven by either time window. The rolling regressions are in line with this view, lending credibility to the robustness of the estimates.[8]

The results support our hypothesis. The portfolio of small growth firms with a strategic CSR implementation realizes a systematic stock market out-

[7]Due to different time windows, the graphical representation of the four-factor model in Figure 5.1 is not directly comparable with the results in Table 5.1 .

[8]As an additional robustness check, we estimated the four-factor model with the both the market return and the risk factors computed on the basis of equally weighted returns. The results did not change. The aim of the matching specification is to improve the balance between the innovator firms and the control firms with respect to the variables assumed to be of relevance. We tried different combinations and transformations of the firm characteristics SIZE, BEME, and MOM and identified the specification (2) as delivering the most balanced samples in our favored matching scenario.

performance during 2002-2009. In terms of the hypothesis, this outperformance might be attributable to overlooked but value-relevant strategic CSR characteristics of these firms and to positive stock price effects resulting from a rapidly growing SRI demand. Due to the size of its stocks, the portfolio is especially prone to such stock price effects because stock price elasticity is likely positively related to firm size. However, there remains a methodological caveat associated with the findings. The results might not be reliable if an inappropriate model was applied to describe equilibrium asset prices. To clear up doubt on the reliability of the results, in the next section we evaluate the performance of the innovator portfolio compared to similar benchmark portfolios.

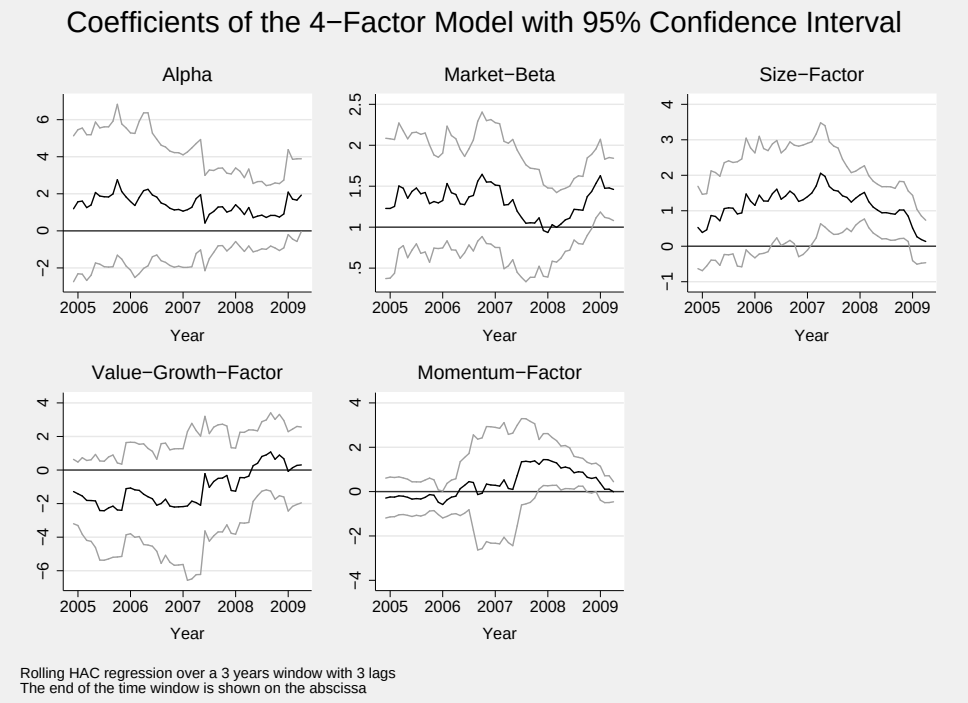

Figure 5.1: Coefficients with 95% confidence interval of rolling regression in the four-factor model

5.5 Robustness checks

5.5.1 A matching approach

Market efficiency can only be tested jointly with some equilibrium model, in this case an asset pricing model. Therefore, one might argue that the interpretation of anomalous evidence is ambiguous, because the hypothesis of zero abnormal returns is tested jointly with the hypothesis that the asset pricing model used to estimate abnormal returns is valid (e.g. Fama, 1970, 1991). This so-called joint hypothesis problem is well known in the literature. It implies that if the used asset pricing model provides an imperfect description of expected returns, the estimated intercept (alpha) represents the combined effects of model misspecification and mispricing. Indeed, the Fama and French (1993) three-factor asset pricing model exhibits difficulties in explaining the average stock return of small firms and firms with high book-to-market ratios (e.g. Barber and Lyon, 1997). In particular, Fama (1998) is concerned with bad model problems when considering equal weighted portfolios because all common asset pricing models have systematic problems in explaining the average returns of small stocks. The joint hypothesis problem thus seems to be of eminent interest when equal weighted stock returns of small to middle sized growth firms are analyzed. This motivates further robustness checks in our case.

Lyon et al. (1999) demonstrate that the three-factor model is misspecified for samples of non-randomly selected firms. They recommend comparing sample firms to the general population based on size ($SIZE$) and book-to-market equity ratios ($BEME$) as well as on the pre-event return performance and other characteristics. Likewise, Barber and Lyon (1997) favor this control firm approach when comparing different buy-and-hold abnormal return methods to evaluate long-run abnormal returns in event studies.

In order to investigate if the results in Section 4 are driven by bad model problems, we investigate whether we find similar anomalous evidence in port-

folios with similar characteristics as the innovator portfolio. For one, the innovator portfolio is biased in $SIZE$ and $BEME$. It also reveals substantial country- and industry-specific expositions. One might argue that some of these extreme portfolio characteristics produce extrapolation bias or that the linearly specified Carhart four-factor model might not be well specified to explain the returns of this portfolio. Ho et al. (2007) illustrate that model dependence in general can be reduced by combining the estimation of structural equation models with data preprocessing by matching treatment and control groups. The central idea of this approach is that if exact matching is not feasible, common parametric procedures can potentially improve inference even after matching because of variation in the covariates. In this vein, we compare the asset pricing model estimates of the innovator portfolio to synthetic reference portfolios with similar characteristics. If these control portfolios exhibit similar abnormal returns in comparison to the innovator portfolio, we have evidence that the Carhart four-factor model might indeed suffer from misspecification for this portfolio type.

Portfolio matching methods have been applied previously in the literature. Mitchell and Stafford (2000), for example, consider $SIZE$ and $BEME$ in the construction of reference portfolios on the basis of specific portfolio assignments. In contrast to their approach we construct reference portfolios not by traditional matching methods but by matching the innovators to all European firms in the market based on a propensity score. Conventional matching approaches notoriously have difficulties in simultaneously matching multiple dimensions. Their sequential approach - such as prescreening based on $SIZE$, followed by a nearest $BEME$ matching - implies that optimizing matching quality in one dimension usually comes at the cost of deteriorating matching quality in other dimensions. In contrast, propensity score matching (PSM) reduces a multi-dimensional problem to one single score, the propensity score Rosenbaum and Rubin (1983).

Li and Zhao (2006) use PSM to identify similar firms based on size, $BEME$, and momentum. In studying the event-time buy-and-hold abnormal

return approach of firms with primary seasoned equity offerings, Li and Zhao compare the mean and median returns of the event and the matched control firm portfolios, albeit without estimating any parametrical model. They find that the PSM method delivers better results than the conventional matching methods applied by Lyon et al. (1999), explaining away partially the anomalous behavior of small issuers. They also find that adding additional variables in the propensity score specification estimation has only marginal effects. In other settings, PSM has been applied by Aggarwal et al. (2009) to compare the governance of US and non-US firms and by Drucker and Puri (2005) to investigate the benefits of concurrent lending and underwriting. To our knowledge, PSM has yet to be applied in conjunction with asset pricing models to evaluate abnormal returns. We take up on the argument of Ho et al. (2007) and combine PSM with a structural model in order to check for model dependence.

In the estimation of the propensity score variables affecting the dependent and the treatment variable should be included, termed "minimum relevant information set" by Heckman and Navarro-Lozano (2004). On this note, following Li and Zhao (2006) we use firm level $SIZE$, $BEME$, and 11-month pre-matching momentum (MOM) for a 1-to-1 nearest neighbor propensity score matching. We argue that using a PSM, we can construct an appropriate evaluation benchmark to reappraise the robustness of our results.

If a firm is identified by the ZKB research team as an innovator in year γ, the firm is retained in the innovator portfolio in the year $\gamma + 1$. This implies that the innovator portfolio is sorted in December of year γ and its holding period is $\gamma + 1$.

$$\Lambda(\mathbf{x}_\tau, \beta) = Prob(Innovator = yes|\mathbf{x_t}) \tag{5.2}$$

$$\mathbf{x}_\tau^{'} = SIZE_\tau, log(SIZE_\tau), log(SIZE_\tau)^2, log(SIZE_\tau)^3, BEME_\tau, MOM_\tau \tag{5.3}$$

Each December, we estimate equation 5.2 with a logistic regression. If

linear covariates in the propensity score estimation are not producing good matching quality, higher order terms or interaction terms should be added according to Rosenbaum and Rubin (1983). Starting with linear covariates, we added transformations of the $SIZE$ variable to obtain better balance on this dimension, tried different other specifications, and concluded that the predictor variables in vector x_τ of equation 5.3 deliver the best balance as measured by mean and median differences for pooled PSM over all years.[9] The index τ is a monthly indicator and fixed to December of each year in equation 5.3. $SIZE_\tau$ is the market value in million USD, the book-to-market ratio $BEME_\tau$ is the ratio of common equity to the market value of equity, and MOM_τ is the geometric average of the monthly returns over a window of 11 months from $t-12$ to $t-2$.[10] Based on the vector x_τ, the probability of being an innovator firm is predicted for the general population of European firms. For the matching procedure, we adhere to the guidelines provided by Guo and Fraser (2009) and use the predicted probability p to define $logit = log(\frac{1-p}{p})$ as the propensity score. In turn, this score is used for a 1-to-1 matching without replacement in descending order with a caliper of one-fourth of the standard deviation of the annual propensity scores to ensure a certain level of common support. The matching procedure is done using the Stata package psmatch2 from Leuven and Sianesi (2003). Nearest neighborhood matching is executed separately every year. In the base case scenario the nearest matches are restricted to the same countries because our result might have been confounded by the overrepresentation of German firms in our sample.[11] Due to this country restriction and the used caliper,

[9]The aim of the matching specification is to improve the balance between the innovator firms and the control firms with respect to the variables assumed to be of relevance. We tried different combinations and transformations of the firm characteristics $SIZE$, $BEME$, and MOM and identified the specification 5.3 as delivering the most balanced samples in our favored matching scenario.

[10]Per common practice, common equity is required to be greater. In addition, we added investment tax credits to common equity.

[11]The Thomson Reuters Datastream Variable 'GEOGN' was used as the country iden-

innovator firms are being dropped in a specific year if no other firm within the same country has a sufficiently close propensity score. Control firms constitute firms in the market with monthly return values in the sorting year and with plausible available values of $SIZE$ and $BEME$ in December of the sorting year.[12] Because the control firm portfolio is held in the months after December of the sorting year, potential control firms need to remain in the market for the entire year after the sorting year. In addition to the country base case we construct two alternative control firm portfolios by restricting the nearest neighborhood PSM to the same industry and (in the most restrictive scenario) to both the same country and industry. The last matching scenario requires exact matching in two dimensions and inflates the number of cells considered. It consequently reduces the number of firms in each cell. Because of the caliper, this results in reduced sample sizes. Whereas our original sample contains 290 firm-observations, the exact country restriction and the exact industry restriction yield 237 and 236 firm-observations, respectively. The most restrictive exact country and industry match leaves us with 199 firm-observations.

Additionally, similar to Mitchell and Stafford (2000) we apply resampling procedures to derive the expected abnormal performance of the innovators given their sample composition. We still identify similar firms by PSM but now match, in each year, the ten most similar firms to every innovator firm. From this pool of control firms we draw 1'000 calendar-time portfolio samples and estimate the expected intercept from these random samples by sampling in each draw (with replacement) 30 control firms in every year. Based on these draws we also estimate the expected intercept of portfolios of innovators that are most similar to the sampled control firms. Applying different matching scenarios, we estimate alpha distributions conditional on differently composed sample compositions. First we use PSM based on the characteristics $SIZE$,

tifier.

[12]Book equity is the sum of common equity and investment tax credit and is restricted not to be negative. In addition, we rely on the filters applied in Schmidt et al. (2011).

$BEME$, and MOM. We then restrict the ten nearest neighbor PSM to the same country and, in addition, to the same industry. Finally, we require an exact country and industry match. In this last matching specification we have to weaken the matching specifications in order to obtain a sufficient sample size by matching only the five nearest neighbors and by dropping the caliper. The resampling approach is of interest because there might not be one specific firm that serves as the definite control firm. Moreover, the considered time period of eight years is not very long but quite turbulent, making it more difficult to find significant results. Therefore, the inspection and comparison of the alpha distribution of resampled control and innovator portfolios might provide additional insight.

5.5.2 Results with control firms

Table A5.8 reports the number of firm-years in the innovator portfolio and the generated portfolio of control firms across different industries for the country match, our base case scenario. Among the industries, "Oil & Gas" and "Industrials" continue covering the major part of firm-years in the innovator portfolio. In contrast, the control firm portfolio reveals a tilt towards "Financials". Table A5.9 verifies the effectiveness of the exact country match. In Tables A5.10, A5.11, and A5.12, the portfolio characteristics $SIZE$, $BEME$, and MOM of the innovator (I), control (C), and market (M) portfolios are juxtaposed. The means and medians of these portfolio characteristics offer a rough picture of the balance improvement achieved by the matching. Table A5.10 lists annual means and Table A5.11 reports annual medians for the three portfolios and the identified portfolio characteristics. On an annual basis, these tables confirm that the characteristics $SIZE$, $BEME$, and MOM are more similar between the innovator and the control firm portfolio than between the innovator and the market portfolio. These properties are summarized in Table A5.12. From 2001 to 2008, the mean absolute difference between the control and innovator portfolio on the one hand and the market

and innovator portfolio on the other hand shows a tenfold reduction in the control portfolio for the characteristic $SIZE$ and a threefold reduction for $BEME$ and MOM in comparison to the market. These absolute differences are averaged across all the years for the annual means and medians of the three characteristics. The absolute mean differences of the medians tell a similar story. The differences in $SIZE$, $BEME$, and MOM are two to seven times smaller for the control firm portfolio than for the market portfolio. The control firm portfolio thus appears to be a more appropriate benchmark for the innovator portfolio. The average monthly return of the market and the risk-free rate in Table A5.13 are taken from Table A5.6. The reduction in the innovator firm-years reduces the average return of the innovator portfolio for the overall period by 0.27% points from 0.74% to 0.47%. This is traceable to the lower return in the first sub-period because the data preprocessing produced a marginal higher innovator return in the second sub-period. The average return of the control firm portfolio for the overall period was a modest 0.21%. The control firm portfolio has achieved a high return in the first sub-period, but this was offset by a large negative return of 1.13% in the second sub-period. Table A5.14 presents the regression results for the Carhart four-factor model for both the innovator and the control firm portfolio. The alpha of the innovator portfolio, which is now reduced in terms of sample size, is significant and 1.34% for the entire time period. Although positive, the according point estimates for the sub-periods are not statistically different from zero. In contrast, the portfolio of control firms never exhibits an alpha different from zero at conventional significance levels. Interestingly, the control firm portfolio mimics market movements more closely than the innovator portfolio with a market beta close to one in all time periods. This holds also true for all the following control firm matching specifications. The parameter estimates of the four-factor model with control firms derived by exact industry matching are shown in Table A5.15. Compared to the country restriction, the industry restriction yields a slightly different sample of innovator firms. However, the alpha for the entire time span remains significant

at 1.37%. Even though none of the alphas of the control firms are statistically different from zero, it should be noted that the point estimates are always positive. What is more, the z-statistic for the overall period proves to be the highest among all the control firm scenarios. This suggests the presence of a certain positive industry effect. The results therefore suggest that the sustainability research team of the ZKB managed to identify outperforming companies within booming industries. In a last robustness check using one-to-one nearest neighbor PSM, we match both by country and industry. The results depicted in Table A5.16 back up the outperformance of the innovator portfolio. The reduction of the innovator alpha to 1.05% and the upward shift of the significance level to 10% can be explained by the substantial reduction of the sample through the caliper matching. In this scenario as well, the alphas of the control firm portfolio are not significant. Finally, Table 5.2 presents the alpha distribution of 1'000 resampled control and innovator portfolios based on the Carhart four-factor model. The parameter values indicate that the alpha distributions are very symmetric. The resampling shows that the 5% percentile of the control portfolio is always negative while the same percentile for the innovator portfolio is always substantially above zero for the innovators. Therefore, 90% of the alphas as enclosed by the 5% and 95% percentiles are substantially above zero for the innovators in each matching scenario while the same distributions for the control firm portfolio include zero. If the asset pricing model we are using were a perfect description of expected returns for the analyzed portfolios, we would expect a mean of zero for the alpha of the control portfolios. However, these means turn out to be positive with a monthly outperformance ranging between 0.16% and 0.31%. This indicates that our alpha estimate for the innovator portfolio should be corrected downwards. We conclude that the returns of our equally weighted innovator portfolio outperformed the market from 1/2002 to 4/2009 by at least around 1% monthly. To sum up, despite the stringent country and industry matchings, the performance of the innovator portfolio remains robust in all scenarios, providing additional support for our hypothesis.

Table 5.2: Alpha (α) distribution of random samples of innovator and control firms for the period 01/2002-04/2009

		α			
Matching Characteristics	Portfoliotype	mean	p5	p50	p95
Size, BEME, MOM	Innovators	1.42	0.79	1.42	2.06
	Control Firms	0.16	-0.44	0.17	0.79
Size, BEME, MOM, Country	Innovators	1.47	0.83	1.49	2.07
	Control Firms	0.29	-0.31	0.29	0.92
Size, BEME, MOM, Sector	Innovators	1.49	0.88	1.50	2.1
	Control Firms	0.31	-0.33	0.31	0.99
Size, BEME, MOM, Country, Sector	Innovators	0.99	0.42	0.99	1.53
	Control Firms	0.23	-0.39	0.23	0.84

p5, p50, and p95 are the 5%, 50%, and 95% percentiles, respectively

5.6 Conclusion

There are no established characteristics that divide firms into an SRI class, let alone a class that reflects a distinct strategic sustainability concept. Instead, many studies apply indices that are specifically built to arrange such a categorization. It stands to reason that within such indices, elaborate as they are, specific performance-driving effects of SRI might get lost in aggregation. In other words, the validity of conclusions with respect to SRI and financial performance hinges on the construction of the SRI class. Our basket of innovators reflects the specific notion of strategic CSR and therefore circumvents this issue. In addition, the synthetic portfolio offers a glimpse at a portfolio selection stage that is not distorted by active portfolio management skills.

The case for positive abnormal returns of this portfolio is given by a hypothesis that rests upon two channels. On the one hand, value-relevant information of strategic CSR may not have been priced in by the market.

On the other hand, market disequilibrium caused by rising demand for SRI assets might have produced positive returns via stock price effects. To test the hypothesis of positive abnormal returns, we conduct a portfolio analysis based on a novel comprehensive dataset with pan-European Carhart risk factors. This accounts for the well-known systematic risks in SRI portfolios and eschews mistaken attributions of observed out- or underperformance. The results of the portfolio analysis strongly support the hypothesis of financial outperformance with a stable alpha of 1.30% per month.

Even so, one might argue that the financial performance driver might be confounded by bad model problems due to firm characteristics. To mitigate this possibility, we construct synthetic benchmark portfolios with similar control firms, additionally accounting for country and industry clusters. The matched portfolios underpin the significant financial outperformance of the innovators. A final prudent resampling approach yields a more conservative innovators alpha of roughly 1%. In other words, none of the robustness checks qualify the general results.

It is instructive to discuss the implications of both arguments of the hypothesis. Most CSR research has focused on easily quantifiable CSR characteristics for large firms. By now, potentially value-relevant factors embedded within or proxied by these characteristics can be extracted systematically and with reasonable costs thanks to the surge of CSR databases. In contrast, CSR features that need to be processed more comprehensively on a case to case basis, such as strategies, demand skilled expertise and come at a cost, in particular when the focus is on small firms. One can argue that if there is something value-relevant to be found, it is more likely to happen in areas which are tougher to decipher. So any financial outperformance that lures in these niches has to make up for the research costs that are associated with this task. This suggests that one might keep encountering financial outperformance in market niches that are new and unfamiliar. On that notion, our results suggest that strategic CSR for small and innovative firms seems to evoke a market anomaly in terms of systematic outperformance that has yet

to be priced in by the market.

The mere growth of SRI assets as the second argument draws attention to an overlooked dynamic in the existing CSR literature. Whenever investors deviate from market weights, the ensuing rising demand can temporarily give rise to abnormal returns due to stock market frictions. We present empirical evidence to support this argument for Europe in the last decade. With an increasingly saturated SRI market in the US, the ongoing SRI expansion in Europe lends itself to be a more fertile ground for positive abnormal returns, particularly with respect to small stocks. By and large, existing SRI research has focused on big stocks. However, ever since Merton (1987), there is a theoretical case for small stocks, and given our results, it seems worthwhile to engage in future research with European SRI data to raise more evidence. Notably for our portfolio, policy regulations could amplify abnormal returns. For example, the extensive subsidies for renewable energies in Germany could have distorted the allocation of SRI assets.

Our results are of high practical importance for both investors and a firm's management. At first glance, it seems that investing in small and innovative firms that focus on strategic sustainability kills two birds with one stone. Socially responsible investing in strategic CSR can be quite lucrative, at least on the revenue side. But this comes at a cost. On the expenditure side, research costs have to be taken into account, costs that are likely to be associated with expertise that gradually builds up over time. For the management, our results may serve as important advice. If value-relevant information is disclosed more transparently, the firm is more attractive to the market. It falls to the management how this can be conveyed credibly.

It would be revealing to disentangle the two channels. In our case, a longer time horizon might allow for a distinction of the two effects if we were to observe how differently, if at all, the abnormal behavior evolves in the long run. A convergence of future abnormal returns towards zero would make for a case of errors of investors' expectations. On the other hand, if abnormal returns eventually turn negative, it would suggest that equilibrium

in the SRI investor share has been reached. Finally, if both abnormal and absolute returns turn negative, we might observe a shrinking proportion of SRI investors. One might label this situation as the burst of a financial SRI bubble. Given the magnitude of our results, the two channels might well be simultaneously at work. If anything, our data is only weakly indicative in the sense that the lack of an observable negative trend of the alpha point estimates in the rolling regression does not suggest a decreasing effect of SRI growth. Analyzing according US data from the past two decades in light of the slowing growth of SRI assets could shed more light on this question.

5.7 Tables and figures

Table A5.3: No. of Innovators and market values

		Average Market Value (Mio USD)	
Year	No. of Firms	Innovators	European Firms
2002	16	332	997
2003	17	595	1299
2004	13	396	1608
2005	17	777	1648
2006	30	1178	2074
2007	45	2288	2364
2008	75	645	1185
2009	77	875	1183

Table A5.4: No. of Innovators across industries

Industries	No. of Firms
Basic Materials	16
Consumer Goods	6
Consumer Services	1
Financials	12
Healthcare	3
Industrials	80
Oil & Gas	113
Technology	17
Utilities	42
Total	290

Table A5.5: No. of Innovators across subsectors

Subsectors	No. of Firms
Alt. Electricity	32
Alternative Fuels	16
Auto Parts	4
Banks	8
Building Mat.& Fix.	15
Con. Electricity	7
Containers & Package	4
Dur. Household Prod.	4
Electrical Equipment	3
Electronic Equipment	3
Financial Admin.	7
Forestry	9
Healthcare Providers	2
Hotels	1
Industrial Machinery	31
Industrial Suppliers	1
Investment Services	4
Marine Transportation	1
Medical Equipment	1
Oil Equip. & Services	2
Renewable Energy Eq.	100
Semiconductors	4
Software	1
Specialty Chemicals	7
Telecom. Equipment	12
Waste, Disposal Svs.	8
Water	3
Total	290

Table A5.6: No. of innovators across countries

Countries	No. of Firms
Denmark	9
Finland	4
France	9
Germany	175
Greece	2
Italy	2
Netherlands	2
Norway	11
Spain	14
Sweden	2
Switzerland	26
United Kingdom	34
Total	290

Table A5.7: Average monthly returns over time in %

	rm_t	rf_t	Innovators$_t$	SMB_t	HML_t	WML_t
1/2002 - 4/2009	0.3	0.31	0.74	0.41	0.55	1.12
	(0.59)	(0.01)	(1.06)	(0.24)	(0.15)	-0.45
1/2002 - 8/2005	1.37	0.23	1.4	0.8	1.05	1.08
	(0.67)	(0.00)	(1.38)	(0.31)	(0.24)	-0.68
9/2005 - 4/2009	-0.78	0.39	0.08	0.03	0.05	1.16
	(0.95)	(0.02)	(1.63)	(0.37)	(0.14)	-0.59

Average geometric returns are displayed and standard errors are shown in parenthesis. Value weighted returns are presented for the market return rm_t and the factors SMB, HML, and WML. Equally weighted returns are displayed for the Innovator portfolio. rf_t is the risk-free rate.

Table A5.8: No. of innovators and control firms across countries (country matched)

Industries	No. of Innovators	No. of Control Firms
Denmark	9	9
Finland	4	4
France	6	6
Germany	140	140
Italy	1	1
Netherlands	2	2
Norway	10	10
Spain	13	13
Sweden	2	2
Switzerland	23	23
United Kingdom	27	27
Total	237	237

Table A5.9: No. of innovators and control firms across industries (country matched)

Industries	No. of Innovators	No. of Control Firms
Basic Materials	13	15
Consumer Goods	4	26
Consumer Services	1	35
Financials	10	50
Healthcare	3	16
Industrials	68	53
Oil & Gas	88	6
Technology	16	28
Telecommunications	0	4
Utilities	34	4
Total	237	237

Table A5.10: Annual means of innovator (I), control (C), and market (M) portfolio characteristics

Year	*SIZE*			*BEME*			*MOM*			No. of Firms		
	I	C	M	I	C	M	I	C	M	I	C	M
2002	859	917	1359	0.20	0.21	1.03	-5.81	-4.68	-3.69	10	10	4557
2003	471	526	1285	1.07	1.41	1.20	-6.29	-6.14	-1.37	14	14	4338
2004	285	123	1660	0.93	0.89	0.92	2.06	2.22	2.91	13	13	4235
2005	642	401	2103	0.76	0.59	0.81	1.74	2.70	1.69	15	15	4222
2006	693	597	2221	0.41	0.32	0.71	5.00	4.95	1.79	25	25	4257
2007	1220	1223	2702	0.40	0.42	0.68	1.70	1.24	1.94	31	31	4530
2008	2127	1854	3178	0.41	0.50	0.78	3.42	4.41	1.80	58	58	4343
2009	648	573	1451	1.25	1.41	1.96	-5.14	-5.28	-4.87	71	71	4556

The month December is used to calculate the means. Size stands for the market value of a firm and is denominated in Mio USD.

Table A5.11: Annual medians of innovator (I), control (C), and market (M) portfolio characteristics

Year	*SIZE*			*BEME*			*MOM*			No. of Firms		
	I	C	M	I	C	M	I	C	M	I	C	M
2002	460	465	75	0.14	0.18	0.68	-6.01	-4.34	-2.01	10	10	4557
2003	76	59	73	0.76	0.62	0.81	-7.50	-3.2	-0.30	14	14	4338
2004	78	66	107	0.76	0.79	0.64	1.83	1.99	2.77	13	13	4235
2005	126	91	140	0.53	0.48	0.57	1.69	2.80	1.82	15	15	4222
2006	244	234	146	0.26	0.28	0.47	4.96	4.31	1.75	25	25	4257
2007	345	339	177	0.29	0.38	0.45	2.01	1.89	2.00	31	31	4530
2008	545	610	204	0.25	0.38	0.46	4.23	3.84	1.76	58	58	4343
2009	190	201	76	0.64	0.78	1.04	-4.27	-4.88	-4.29	71	71	4556

The month December is used to calculate the means. Size stands for the market value of a firm and is denominated in Mio USD.

Table A5.12: Mean absolute portfolio difference as compared to the innovator portfolio over the period 2001-2008

	Mean			Median		
	$SIZE$	$BEME$	MOM	$Size$	$BEME$	MOM
Control Firms	120.38	0.12	0.50	20.13	0.08	1.13
Remaining Market	1126.75	0.33	1.66	144	0.21	2.25

In every year absolute differences are built between Control Firms and Innovators and the Market and Innovators for Table 8 and 9. Then the mean over the years is calculated.

Table A5.13: Average monthly returns over time (geometric returns in %)

	rm_t	rf_t	Innovators$_t$	Control Firms$_t$
1/2002 - 4/2009	0.3	0.31	0.47	0.21
	(0.59)	(0.01)	(1.18)	(0.81)
1/2002 - 8/2005	1.37	0.23	0.85	1.56
	(0.67)	(0.00)	(1.34)	(0.89)
/2005 - 4/2009	-0.78	0.39	0.09	-1.13
	(0.95)	(0.02)	(1.96)	(1.34)

Average geometric returns are displayed and standard errors are shown in parenthesis. Value weighted returns are presented for the market return rmt and equally weighted returns are displayed for the Innovator portfolio. rf_t is the risk-free rate.

Table A5.14: Exact country match: Parameter estimates and Z-statistics in the four-factor model for different time periods

	α	$rm_t - r_{it}$	SMB_t	HML_t	WML_t	R^2
			01/2002-04/2009			
Innovators	1.34**	1.39***	0.51	-1.12**	-0.33	0.62
	(2.17)	(12.04)	(1.52)	(-2.43)	(-1.53)	
Control Firms	-0.18	0.94***	0.46**	0.25	-0.17	0.57
	(-0.47)	(8.82)	(2.07)	(0.64)	(-0.77)	
			01/2002- 08/2005			
Innovators	1.3	1.30***	1.12**	-1.61***	-0.53*	0.49
	(1.03)	(4.94)	(2.12)	(-2.74)	(-1.74)	
Control Firms	0.14	0.83***	0.31	0.20	-0.19	0.27
	(0.15)	(5.10)	(0.55)	(0.36)	(-0.52)	
			09/2005-04/2009			
Innovators	1.32	1.38***	0.27	1.01	-0.08	0.76
	(1.49)	(9.13)	(0.88)	(1.1)	(-0.31)	
Control Firms	-0.15	0.96***	0.51**	0.41	-0.18	0.78
	(-0.31)	(7.00)	(2.54)	(0.81)	(-1.06)	

* (**, ***) means that the parameter is different from zero at the 10% (5%, 1%) significance level, respectively. The parentheses below the point estimates contain the z-statistics, corrected for heteroskedasticity and autocorrelation up to three lags.

Table A5.15: Exact industry match: Parameter estimates and Z-statistics in the four-factor model for different time periods

	α	$rm_t - r_{it}$	SMB_t	HML_t	WML_t	R^2
			01/2002-04/2009			
Innovators	1.37**	1.40***	0.52	-1.12**	-0.32	0.62
	(2.21)	(12.25)	(1.51)	(-2.41)	(-1.49)	
Control Firms	0.78	1.08***	0.61**	0.47	-0.46**	0.65
	(1.36)	(10.3)	(2.56)	(0.74)	(-2.07)	
			01/2002- 08/2005			
Innovators	1.43	1.31***	1.10**	-1.63***	-0.52*	0.5
	(1.13)	(5.06)	(2.09)	(-2.77)	(-1.73)	
Control Firms	0.92	0.96***	0.78	0.56	-0.80***	0.5
	(0.84)	(4.45)	(1.10)	(0.72)	(-3.07)	
			09/2005-04/2009			
Innovators	1.27	1.37***	0.29	1.10	-0.06	0.76
	(1.42)	(8.86)	(0.87)	(1.11)	(-0.25)	
Control Firms	0.44	1.16***	0.45**	1.02	-0.00	0.78
	(0.66)	(7.27)	(2.39)	(1.51)	(-0.01)	

* (**, ***) means that the parameter is different from zero at the 10% (5%, 1%) significance level, respectively. The parentheses below the point estimates contain the z-statistics, corrected for heteroskedasticity and autocorrelation up to three lags.

Table A5.16: Exact country-industry match: Parameter estimates and Z-statistics in the four-factor model for different time periods

	α	$rm_t - r_{it}$	SMB_t	HML_t	WML_t	R^2
			01/2002-04/2009			
Innovators	1.09*	1.28***	0.55*	-1.08***	-0.39**	0.62
	(1.75)	(12.30)	(1.94)	(-2.82)	(-2.06)	
Control Firms	0.08	1.00***	0.22	0.14	0.06	0.57
	(0.14)	(8.12)	(0.88)	(0.41)	(0.40)	
			01/2002- 08/2005			
Innovators	0.82	1.32***	1.03*	-1.41**	-0.52*	0.48
	(0.65)	(4.90)	(1.94)	(-2.66)	(-1.80)	
Control Firms	0.69	0.84***	0.58	-0.23	-0.10	0.29
	(0.79)	(3.62)	(1.56)	(-0.61)	(-0.54)	
			09/2005-04/2009			
Innovators	1.03	1.22***	0.42	0.78	-0.18	0.77
	(1.23)	(8.81)	(1.50)	(0.97)	(-0.89)	
Control Firms	-0.23	1.04***	-0.04	1.01	0.24	0.72
	(-0.32)	(6.49)	(-0.17)	(1.48)	(1.00)	

* (**, ***) means that the parameter is different from zero at the 10% (5%, 1%) significance level, respectively. The parentheses below the point estimates contain the z-statistics, corrected for heteroskedasticity and autocorrelation up to three lags.

References

Aggarwal, R., Erel, I., Stulz, R., and Williamson, R. (2009). Differences in Governance Practices between U. S. and Foreign Firms: Measurement, Causes, and Consequences. *The Review of Financial Studies*, 22(8):3131–3169.

Allcott, H. and Greenstone, M. (2012). Is There an Energy Efficiency Gap? *Journal of Economic Perspectives*, 26(1):3–28.

Almer, C. and Winkler, R. (2012). The Effect of Kyoto Emission Targets on Domestic CO2 Emissions: A Synthetic Control Approach*.

Ambec, S. and Lanoie, P. (2007). When and why does it pay to be green?

Ambec, S. and Lanoie, P. (2008). Does It Pay to Be Green ? A Systematic Overview. *Academy of Management Perspectives*, 22(4):45–62.

Ammann, M., Oesch, D., and Schmid, M. M. (2011). Corporate Governance and Firm Value : International Evidence. *Journal of Empirical Finance*, 18:36–55.

Anderson, S. T. and Newell, R. G. (2004). Information programs for technology adoption : the case of energy-efficiency audits. *Resource and Energy Economics*, 26:27–50.

Angrist, J. D. and Pischke, J.-S. (2008). *Mostly Harmless Econometrics: An Empiricist's Companion*. Princeton University Press.

Arellano, M. and Bond, S. (1991). Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations. *The Review of Economic Studies*, 58(2):277–297.

Arrow, K. J. (1951). An Extension of the Basic Theorems of Classical Welfare Economics. In *Second Berkeley Symposium on Mathematical Statistics and Probability*, volume -1, pages 507–532.

Bagnoli, M. and Watts, S. G. (2003). Selling to Socially Responsible Consumers: Competition and the Private Provision of Public Goods. *Journal of Economics & Management Strategy*, 12(3):419–445.

Baker, M., Stein, J. C. ., and Wurgler, J. (2003). When Does the Market Matter? Stock Prices and the Investment of Equity-Dependent Firms. *The Quarterly Journal of Economics*, 118(3):969–1005.

Baltagi, B. H. (2008). *Econometric analysis of panel data*. John Wiley & Sons.

Banz, R. W. (1981). The Relationship between Return and Merket Value of Common Stocks. *Journal of Financial Economics*, 9:3–18.

Barber, B. M. and Lyon, J. D. (1997). Detecting long-run abnormal stock returns: The empirical power and specification of test statistics. *Journal of Financial Economics*, 43(3):341–372.

Barnett, M. L. and Salomon, R. M. (2006). Beyond Dichotomy: The Curvilinear Relationship between Social Responsibility and Financial Performance. *Strategic Management Journal*, 27(September):1101–1122.

Baron, D. P. (2001). Private Politics, Corporate Social Responsibility, and Integrated Strategy. *Journal of Economics & Management Strategy*, 10(1):7–45.

Baron, D. P. (2008). Managerial contracting and corporate social responsibility. *Journal of Public Economics*, 92(1-2):268–288.

Barro, R. J. (1990). The stock market and investment. *The Review of Financial Studies*, 3(1):115–131.

Basu, S. (1977). Investment Performance of Common Stocks in Relation to Their Price-Earnings Ratios : A Test of the Efficient Market Hypothesis. *The Journal of Finance*, 32(3):663–682.

Bauer, R., Derwall, J., and Otten, R. (2007). The Ethical Mutual Fund Performance Debate: New Evidence from Canada. *Journal of Business Ethics*, 70(2):111–124.

Bauer, R., Koedijk, K., and Otten, R. (2005). International evidence on ethical mutual fund performance and investment style. *Journal of Banking & Finance*, 29(7):1751–1767.

Bebchuk, L., Cohen, A., and Ferrell, A. (2008). What Matters in Corporate Governance? *Review of Financial Studies*, 22(2):783–827.

Bebchuk, L. a., Cohen, A., and Wang, C. C. (2013). Learning and the disappearing association between governance and returns. *Journal of Financial Economics*, 108(2):323–348.

Bebchuk, L. A. and Hamdani, A. (2009). The Elusive Quest for Global Governance Standards. *University of Pennsylvania Law Review*, 157:1263–1317.

Berkowitz, M. K. and Qiu, J. (2001). Common Risk Factors in Explaining Canadian Equity Returns.

Besley, T. and Ghatak, M. (2001). Government versus private ownership of public goods. *The Quarterly Journal of Economics*, (November):1343–1372.

Besley, T. and Ghatak, M. (2007). Retailing public goods: The economics of corporate social responsibility. *Journal of Public Economics*, 91(9):1645–1663.

Betzer, A., Doumet, M., and Rinne, U. (2013). How policy changes affect shareholder wealth: the case of the Fukushima Dai-ichi nuclear disaster. *Applied Economics Letters*, 20(8):799–803.

Bhandari, L. C. (1988). Debt/Equity Ratio and Expected Common Stock Returns: Empirical Evidence. *Journal of Finance*, 43(2):507–528.

Blacconiere, W. G. and Northcut, W. D. (1997). Environmental Information and Market Reactions to Environmental Legislation. *Journal of Accounting, Auditing & Finance*, 12(2):149–178.

Blacconiere, W. G. and Patten, D. M. (1994). Environmental disclosures, regulatory costs, and changes in firm value. *Journal of Accounting and Economics*, 18(3):357–377.

Blanco, E., Rey-Maquieira, J., and Lozano, J. (2009). The Economic Impacts of Voluntary Environmental Performance of Firms: a Critical Review. *Journal of Economic Surveys*, 23(3):462–502.

Bloom, N., Genakos, C., Martin, R., and Sadun, R. (2010). Modern Management: Good for the Environment or Just Hot Air? *The Economic Journal*, 120:551–572.

Bloom, N. and Reenen, J. V. (2010). Why Do Management Practices Differ across Firms and Countries ? *Journal of Economic Perspectives*, 24(1):203–224.

Bloom, N. and Van Reenen, J. (2007). Measuring and Explaining Management Practices Across Firms and Countries. *Quarterly Journal of Economics*, CXXII(November).

Boehmer, E., Musumeci, J., and Annette B. Poulsen (1991). Event-study methodology under conditions of event-induced variance. *Journal of Financial Economics*, 30:253–72.

Böhringer, C. and Vogt, C. (2004). The dismantling of a breakthrough: the Kyoto Protocol as symbolic policy. *European Journal of Political Economy*, 20(3):597–617.

Bollen, N. P. B. and Busse, J. A. (2005). Short-Term Persistence in Mutual Fund Performance. *Review of Financial Studies*, 18(2):569–597.

Bond, S. (2002). Dynamic panel data models: a guide to micro data methods and practice. *Portuguese Economic Journal*, 1(2):141–162.

Bowen, R. M., Castanias, R. P., and Daley, L. A. (1983). Intra-Industry Effects of the Accident at Three Mile Island. *The Journal of Financial and Quantitative Analysis*, 18(1):87.

Brekke, K. A. and Nyborg, K. (2008). Attracting responsible employees: Green production as labor market screening. *Resource and Energy Economics*, 30(4):509–526.

Brown, S. J. and Warner, J. B. (1980). Measuring security price performance. *Journal of Financial Economics*, 8:205–258.

Busch, T. and Hoffmann, V. H. (2011). How Hot Is Your Bottom Line? Linking Carbon and Financial Performance. *Business & Society*, 50(2):233–265.

Bushnell, J., Mansur, E. T., Chong, H. G., Bushnell, J. B., and Chong, H. (2011). Profiting from Regulation : An Event Study of the European Carbon Market.

Cañón-de Francia, J. and Garcés-Ayerbe, C. (2009). ISO 14001 Environmental Certification: A Sign Valued by the Market? *Environmental and Resource Economics*, 44(2):245–262.

Campbell, J. Y., Lo, A. W., MacKinlay, A. C., and Lo, A. Y. (1996). *The Econometrics of Financial Markets*. Princeton University Press.

Capelle-Blancard, G. and Laguna, M.-A. (2010). How does the stock market respond to chemical disasters? *Journal of Environmental Economics and Management*, 59(2):192–205.

Capelle-Blancard, G. and Monjon, S. (2013). The Performance of Socially Responsible Funds: Does the Screening Process Matter? *European Financial Management*, page forthcoming.

Carbon Tracker Initiative (2011). Unburnable Carbon - Are the world's financial markets carrying a carbon bubble? Technical report, Carbon Tracker Initiative, London.

Carhart, M. M. (1997). On Persistence in Mutual Fund Performance. *The Journal of Finance*, 52(1):57–82.

Cass, D. (1965). Optimum Growth in an Aggregative Model of Capital Accumulation. *The Review of Economic Studies*, 32(3):233–240.

Chan, L. K. C., Hamao, Y., and Lakonishok, J. (1991). Fundamentals and Stock Returns in Japan. *The Journal of Finance*, 46(5):1739–1764.

Chung, K. H. and Pruitt, S. W. (1994). A Simple Approximation of Tobin's q. *Financial Management*, 23(3):70.

Coase, R. H. (1937). The Nature of the Firm. *Economica*, 4(16):386–405.

Coase, R. H. (1960). The Problem of Social Cost. *Journal of Law and Economics*, 3:1–44.

Coase, R. H. (1974). The Lighthouse in Economics. *Journal of Law and Economics*, 17(2):357–376.

Coase, R. H. (1988). *The firm, the market, and the law*. University of Chicago Press, Chicago.

Cole, M. a., Elliott, R. J., Okubo, T., and Zhou, Y. (2013). The carbon dioxide emissions of firms: A spatial analysis. *Journal of Environmental Economics and Management*, 65(2):290–309.

Cortez, M. C., Silva, F., and Areal, N. (2012). Socially Responsible Investment in the Global Market: The Performance of US and European Funds. *International Journal of Finance and Economics*, 17:254–271.

Cropper, M. L. and Oates, W. E. (1992). Environmental Economics: A Survey. *Journal of Economic Literature*, 30(2):675–740.

Darnall, N. and Carmin, J. (2005). Greener and cleaner? The signaling accuracy of U.S. voluntary environmental programs. *Policy Sciences*, 38(2-3):71–90.

Dasgupta, P. and Heal, G. (1974). The optimal depletion of exhaustible resources. *The Review of Economic Studies*, pages 3–28.

Dasgupta, S., Laplante, B., and Mamingi, N. (2001). Pollution and Capital Markets in Developing Countries. *Journal of Environmental Economics and Management*, 42(3):310 – 335.

DeBondt, W. F. M. and Thaler, R. (1985). Does the Stock Market Overreact? *The Journal of Finance*, 40(3):793–805.

Debreu, G. (1959). *Theory of Value: An Axiomatic Analysis of Economic Equilibrium*. Yale University Press.

DeMiguel, V., Garlappi, L., and Uppal, R. (2009). Optimal Versus Naive Diversification: How Inefficient is the 1/N Portfolio Strategy? *Review of Financial Studies*, 22(5):1915–1953.

Derwall, J., Bauer, R., Guenster, N., and Koedijk, K. C. G. (2005). The Eco-Efficiency Premium Puzzle. *Financial Analysts Journal*, 61(2):51–63.

Derwall, J., Koedijk, K., and Ter Horst, J. (2011). A tale of values-driven and profit-seeking social investors. *Journal of Banking & Finance*, 35(8):2137–2147.

Doidge, C., Karolyi, G., and Stulz, R. M. (2004). Why are foreign firms listed in the U.S. worth more? *Journal of Financial Economics*, 71(2):205–238.

Dowell, G., Hart, S. L., and Yeung, B. (2000). Do Corporate Global Environmental Standards Create or Destroy Market Value? *Management Sciences*, 46(8):1059–1074.

Drucker, S. and Puri, M. (2005). On the Benefits of Concurrent Lending and Underwriting. *The Journal of Finance*, 60(6):2763–2799.

Durnev, A. and Kim, E. H. (2005). To Steal or Not to Steal: Firm Attributes, Legal Environment, and Valuation. *The Journal of Finance*, 60(3):1461–1493.

Eccles, R. G., Ioannou, I., and Serafeim, G. (2011a). The Impact of a Corporate Culture of Sustainability on Corporate Behavior and Performance.

Eccles, R. G., Serafeim, G., and Krzus, M. P. (2011b). Market Interest in Nonfinancial Information. *Journal of Applied Corporate Finance*, 23(4):113–127.

Elsayed, K. and Paton, D. (2005). The impact of environmental performance on firm performance: static and dynamic panel data evidence. *Structural Change and Economic Dynamics*, 16(3):395–412.

Eurosif (2003). Socially Responsible Investment among European Institutional Investors. Technical report, European Sustainable Investment Forum.

Eurosif (2008). European SRI Study. Technical report, European Sustainable Investment Forum.

Eurosif (2010). European SRI Study. Technical report, European Sustainable Investment Forum.

Fama, E. F. (1970). Efficient Capital Markets: A Review of Theory and Empirical Work. *The Journal of Finance*, 25(2):383–417.

Fama, E. F. (1991). Efficient Capital Markets : II. *The Journal of Finance*, 46(5):1575–1617.

Fama, E. F. (1998). Market efficiency, long-term returns, and behavioral finance. *Journal of Financial Economics*, 49:283–306.

Fama, E. F. and Blume, M. E. (1966). Filter Rules and Stock-Market Trading. *The Journal of Business*, 39(1):226–241.

Fama, E. F. and French, K. R. (1992). The Cross-Section of Expected Stock Returns. *The Journal of Finance*, 47(2):427.

Fama, E. F. and French, K. R. (1993). Common risk factors in the returns on stocks and bonds. *Journal of Financial Economics*, 33(1):3–56.

Fama, E. F. and French, K. R. (1996). Multifactor Explanations of Asset Pricing Anomalies. *The Journal of Finance*, 51(1):55–84.

Fama, E. F. and French, K. R. (2004). The Capital Asset Pricing Model: Theory and Evidence. *Journal of Economic Perspectives*, 18(3):25–46.

Fama, E. F. and French, K. R. (2012). Size, value, and momentum in international stock returns. *Journal of Financial Economics*, 105(3):457–472.

Fama, E. F. and MacBeth, J. D. (1973). Risk , Return , and Equilibrium : Empirical Tests. *Journal of Political Economy*, 81(3):607–636.

Filbeck, G. and Gorman, R. F. (2004). The Relationship between the Environmental and Financial Performance of Public Utilities. *Environmental & Resource Economics*, 29(2):137–157.

Financial Times (2010). End of US carbon trading looms.

Fisher-Vanden, K. and Thorburn, K. S. (2011). Voluntary corporate environmental initiatives and shareholder wealth. *Journal of Environmental Economics and Management*, 62(3):430–445.

Fleckinger, P. and Glachant, M. (2011). Negotiating a voluntary agreement when firms self-regulate. *Journal of Environmental Economics and Management*, 62(1):41–52.

FNG (2011). Marktbericht Nachhaltige Geldanlagen 2011: Deutschland, Österreich und die Schweiz. Technical report, FNG.

Freedman, M. and Patten, D. M. (2004). Evidence on the pernicious effect of financial report environmental disclosure. *Accounting Forum*, 28(1):27–41.

French, K. R. and Poterba, J. M. (1991). Investor Diversification and International Equity Markets. *The American Economic Review*, 81(2):222–226.

Friedman, M. (1970). The social responsibility of business is to increase its profit. *New York Times Magazine*, page September 13.

Gans, W. and Hintermann, B. (2013). Market Effects of Voluntary Climate Action by Firms: Evidence from the Chicago Climate Exchange. *Environmental and Resource Economics*, 55(2):291–308.

Gompers, P., Ishii, J., and Metrick, A. (2003). Corporate Governance and Equity Prices. *The Quarterly Journal of Economics*, 118(1):107–155.

Greene, W. H. (2002). *Econometric Analysis*. Prentice Hall, 5th edition.

Grossman, S. J. and Stiglitz, J. E. (1980). On the Impossibility of Informationally Efficient Markets. *American Economic Review*, (June):393–408.

Guenster, N., Bauer, R., Derwall, J., and Koedijk, K. (2011). The Economic Value of Corporate Eco-Efficiency. *European Financial Management*, 17(4):679–704.

Guggenberger, P. (2010). The impact of a Hausman pretest on the size of a hypothesis test: The panel data case. *Journal of Econometrics*, 156(2):337–343.

Guo, S. Y. and Fraser, D. M. W. (2009). *Propensity Score Analysis: Statistical Methods and Applications*. Sage Publications, Inc, 1 edition.

Hamilton, J. T. (1995). Pollution as News: Media and Stock Market Reactions to the Toxics Release Inventory Data. *Journal of Environmental Economics and Management*, 28(1):98–113.

Hamilton, S., Jo, H., and Statman, M. (1993). Doing Well While Doing Good ? The Investment Performance of Socially Responsible Mutual Funds. *Financial Analysts Journal*, 49(December):62–67.

Harrington, S. E. and Shrider, D. G. (2013). All Events Induce Variance : Analyzing Abnormal Returns When Effects Vary across Firms Firms. *Journal of Financial and Quantitative Analysis*, 42(1):229–256.

Hart, S. L. (1995). A Natural-Resource-Based View of the Firm. *The Academy of Management Review*, 20(4):986–1014.

Hartzell, J. C. and Starks, L. T. (2003). Institutional Investors and Executive Compensation. *The Journal of Finance*, LVIII(6):2351–2374.

Hausman, D. M. and McPherson, M. S. (2010). *Economic analysis, moral philosophy, and public policy*. Cambridge University Press, New York.

Hausman, J. A. (1978). Specification tests in Econometrics. *Econometrica*, 46(6):1251–1271.

Heal, G. M. (2005). Corporate Social Responsibility - An Economic and Financial Framework. *The Geneva Papers on Risk and Insurance - Issues and Practic*, pages 1–23.

Heckman, J. and Navarro-Lozano, S. (2004). Using Matching, Instrumental Variables, and Control Functions to Estimate Economic Choice Models. *The Review of Economics and Statistics*, 86(1):30–57.

Heinkel, R., Kraus, A., and Zechner, J. (2001). The Effect of Green Investment on Corporate Behavior. *The Journal of Financial and Quantitative Analysis*, 36(4):431–449.

Hens, T. and Rieger, M. O. (2010). *Financial economics: A Concise Introduction to Classical and Behavioral Finance*. Springer, Berlin; London.

Hill, J. and Schneeweis, T. (1983). The Effect of Three Mile Island on Electric Utility Stock Prices: A Note. *The Journal of Finance*, 38(4):1285–1292.

Ho, D. E., Imai, K., King, G., and Stuart, E. A. (2007). Matching as Nonparametric Preprocessing for Reducing Model Dependence in Parametric Causal Inference. *Political Analysis*, 15(3):199–236.

Hong, H. and Kacperczyk, M. (2009). The price of sin: The effects of social norms on markets. *Journal of Financial Economics*, 93(1):15–36.

Hotelling, H. (1931). The Economics of Exhaustible Resources. *The Journal of Political Economy*, 39(2):137–175.

Howarth, R. B., Haddad, B. M., and Paton, B. (2000). The economics of energy efficiency: insights from voluntary participation programs. *Energy Policy*, 28:477–486.

Hussain, I. K. I., Toms, S., and Diacon, S. (2002). Financial Distress , Market Anomalies and Single and Multifactor Asset Pricing Models : New Evidence.

Ince, O. S. and Porter, R. B. (2006). Individual Equity Return Data From Thomson Datastream: Handle With Care! *Journal of Financial Research*, 29(4):463–479.

IPCC (2007). *Climate Change 2007: The Physical Science Basis*. Cambridge University Press.

IPPC (2007). Synthesis Report. Technical Report November, Intergovernmental Panel of Climate Change.

Jegadeesh, N. and Titman, S. (1993). Returns to Buying Winners and Selling Losers: Implications for Stock Market Efficiency. *The Journal of Finance*, 48(1):65.

Jegadeesh, N. and Titman, S. (2001). Profitability of Momentum Strategies : An Evaluation of Alternative Explanations. *The Journal of Finance*, LVI(2):699–720.

Jones, T. M. (1995). Instrumental Stakeholder Theory: A Synthesis of Ethics and Economics. *The Academy of Management Review*, 20(2):404–437.

Kahneman, D. (2012). *Thinking, fast and slow*. Penguin, London.

Kaplan, S. N. . and Zingales, L. (1997). Do Investment-Cash Flow Sensitivities Provide Useful Measures of Financing Constraints ? *The Quarterly Journal of Economics*, 112(1):169–215.

Karolyi, G. A. and Stulz, R. M. (2003). Are financial assets priced locally or globally? In G.M. Constantinides, M. H. and Stulz, R. M., editors, *Handbook of the Economics of Finance*, volume Volume 1, of *Financial Markets and Asset Pricing*, chapter Chapter 16, pages 975–1020. Elsevier.

Karpoff, J. M., Lott, J. R., and Wehrly, E. W. (2005). The Reputational Penalties for Environmental Violations: Empirical Evidence. *Journal of Law and Economics*, 48(2):653–675.

Kempf, A. and Osthoff, P. (2007a). The Effect of Socially Responsible Investing on Portfolio Performance. *European Financial Management*, 13(5):908–922.

Kempf, A. and Osthoff, P. (2007b). The Effect of Socially Responsible Investing on Portfolio Performance. *European Financial Management*, 13(5):908–922.

Khanna, M. (2002). Non-Mandatory Approaches to Environmental Protection. *Journal of Economic Surveys*, 15(3):291–324.

Khanna, M., Quimio, W. R. H., and Bojilova, D. (1998). Toxics Release Information: A Policy Tool for Environmental Protection. *Journal of Environmental Economics and Management*, 36(3):243–266.

Kilian, L. (2009). Not All Oil Price Shocks Are Alike: Disentangling Supply Shocks in the Crude Oil Market. *The American Economic Review*, 99(3):1053–1069.

Kim, E.-H. and Lyon, T. (2011). When Does Institutional Investor Activism Increase Shareholder Value?: The Carbon Disclosure Project. *The B.E. Journal of Economic Analysis & Policy*, 11(1):Article 50.

King, A. A. and Lenox, M. J. (2001). Does It Really Pay to Be Green? An Empirical Study of Firm Environmental and Financial Performance. *Journal of Industrial Ecology*, 5(1):105–116.

King, A. A. and Lenox, M. J. (2002). Exploring the Locus of Profitable Pollution Reduction. *Management Science*, 48(2):289–299.

Kitzmueller, M. and Shimshack, J. (2012). Economic Perspectives on Corporate Social Responsibility. *Journal of Economic Literature*, 50(1):51–84.

Klein, D. B. (2007). Economics and the Distinction between Voluntary and Coercive Action. *Economic Affairs*, 27(4):65–69.

Kolari, J. W., Morgan, J. P., and Texas, A. (2010). Nonparametric Rank Tests for Event Studies.

Kolari, J. W. and Pynnonen, S. (2010). Event Study Testing with Cross-sectional Correlation of Abnormal Returns. *Review of Financial Studies*, 23(11):3996–4025.

Kollmuss, A., Zink, H., and Polycarp, C. (2008). Making sense of the voluntary carbon market: A comparison of carbon offset standards. Technical report, WWF Germany.

Konar, S. and Cohen, M. A. (1997). Information As Regulation: The Effect of Community Right to Know Laws on Toxic Emissions. *Journal of Environmental Economics and Management*, 32(1):109–124.

Konar, S. and Cohen, M. A. (2001). Does the Market Value Environmental Performance?

Koopmans, T. C. (1965). On the concept of optimal economic growth. In *The Economic Approach to Development Planning*, chapter 4, pages 225–287. North-Holland, Amsterdam.

Kothari, S. P. and Warner, J. B. (2007). Econometrics of event studies. In Eckbo, B. E., editor, *Handbook of Empirical Corporate Finance*, chapter 1, pages 3–36. North Holland, 1 edition.

La Porta, R., Lopez de Silanes, F., Shleifer, A., and Vishny, R. W. (2000). Investor Protection and Corporate Governance. *Journal of Financial Economics*, 58:3–27.

Leuven, E. and Sianesi, B. (2003). PSMATCH2: Stata module to perform full Mahalanobis and propensity score matching, common support graphing, and covariate imbalance testing.

L'Her, J.-F., Masmoudi, T., and Suret, J.-M. (2004). Evidence to support the four-factor pricing model from the Canadian stock market. *Journal of International Financial Markets, Institutions and Money*, 14(4):313–328.

Li, X. and Zhao, X. (2006). Propensity score matching and abnormal performance after seasoned equity offerings. *Journal of Empirical Finance*, 13(3):351–370.

Lindenberg, E. B. and Ross, S. a. (1981). Tobin's q Ratio and Industrial Organization. *The Journal of Business*, 54(1):1–32.

Linn, J. (2010). The effect of cap-and-trade programs on firms' profits: Evidence from the Nitrogen Oxides Budget Trading Program. *Journal of Environmental Economics and Management*, 59(1):1–14.

Lintner, J. (1965). The Valuation of Risk Assets and the Selection of Risky Investments in Stock Portfolios and Capital Budgets. *The Review of Economics and Statistics*, 47(1):13–37.

Lipsey, R. G. (2007). Reflections on the general theory of second best at its golden jubilee. *International Tax and Public Finance*, 14(4):349–364.

Lipsey, R. G. and Lancaster, K. (1956). The General Theory of Second Best. *The Review of Economic Studies*, 24(1):11–32.

Lucas, R. E. (1978). Unemployment Policy. *The American Economic Review*, 68(2):353–357.

Lucas, R. E. (1988). On the mechanics of economic development. *Journal of Monetary Economics*, 22(February 1988):3–42.

Lundgren, T. and Olsson, R. (2010). Environmental incidents and firm value - international evidence using a multi-factor event study framework. *Applied Financial Economics*, 20(16):1293–1307.

Lyon, J. D., Barber, B. M., and Tsai, C.-l. (1999). Improved Methods for Tests of Long-Run Abnormal Stock Returns. *Journal of Finance*, 54(1):165–201.

Lyon, T. P. and Maxwell, J. W. (2003). Self-regulation, taxation and public voluntary environmental agreements. *Journal of Public Economics*, 87(7-8):1453–1486.

MacKinlay, A. C. (1997). Event Studies in Economics and Finance. *Journal of Economic Literature*, 35(1):13–39.

Malthus, T. R. (1798). *An Essay on the Principle of Population*. Oxford World's Classics.

Markowitz, H. (1952). Portfolio Selection. *Journal of Finance*, 7(1):77–91.

Markowitz, H. M. (1959). *Portfolio Selection: Efficient Diversification of Investments*, volume 24. Yale University Press.

McFarland, H. (1987). Did Railroad Deregulation Lead to Monopoly Pricing? An Application of q. *The Journal of Business*, 60(3):385–400.

McWilliams, A. and Siegel, D. (1997). Event Studies in Management Research: Theoretical and Empirical Issues. *The Academy of Management Journal*, 40(3):626–657.

McWilliams, A. and Siegel, D. (2001). Corporate Social Responsibility: A Theory of the Firm Perspective. *The Academy of Management Review*, 26(1):117–127.

Meadows, D. H. ., Meadows, D. l. ., Randers, J., and Behrens, W. W. . (1972). The Limits to Growth. Technical Report 1972, Club of Rome.

Meinshausen, M., Meinshausen, N., Hare, W., Raper, S. C. B., Frieler, K., Knutti, R., Frame, D. J., and Allen, M. R. (2009). Greenhouse-gas emission targets for limiting global warming to 2 degrees C. *Nature*, 458(7242):1158–62.

Meng, K. (2013). The Cost of Potential Cap-and-Trade Policy: An Event Study using Prediction Markets and Lobbying Records.

Merton, R. C. (1987). A Simple Model of Capital Market Equilibrium with Incomplete Information. *The Journal of Finance*, 42(3):483–510.

Mitchell, M. L. and Stafford, E. (2000). Managerial Decisions and Long-Term Stock Price Performance. *Journal of Business*, 73(3):287–329.

Mollet, J. C., Arx, U., and Ilić, D. (2013). Strategic sustainability and financial performance: exploring abnormal returns. *Journal of Business Economics*, 83(6):577–604.

Mollet, J. C. and Ilic, D. (2013). Voluntary corporate climate initiatives and regulatory loom : Batten down the hatches.

Mollet, J. C. and Ziegler, A. (2012). Is Socially Responsible Investing Beneficial ? New Empirical Evidence for the US and European Stock Markets.

Moskowitz, M. R. (1972). Choosing Socially Responsible Stocks. *Business and Society Review*, 1(1):71–75.

Mossin, J. (1966). Equilibrium in a Capital Asset Market. *Econometrica*, 34(4):768–783.

Nadel, S. and Therese, L. (2012). Comments on "Is There an Energy Efficiency Gap?".

Newey, W. K. and West, K. D. (1987). A Simple, Positive Semi-Definite, Heteroskedasticity and Autocorrelation Consistent Covariance Matrix. *Econometrica*, 55(3):703–708.

Nickell, S. (1981). Biases in Dynamic Models with Fixed Effects. *Econometrica*, 49(6):1417–1426.

Nordhaus, W. (2007). *The Challenge of Global Warming: Economic Models and Environmental Policy*. New Haven, CT: Yale University.

Oberndorfer, U. (2009). EU Emission Allowances and the stock market: Evidence from the electricity industry. *Ecological Economics*, 68(4):1116–1126.

Oberndorfer, U., Schmidt, P., Wagner, M., and Ziegler, A. (2013). Does the stock market value the inclusion in a sustainability stock index? An event study analysis for German firms. *Journal of Environmental Economics and Management*, page forthcoming.

Patell, J. M. (1976). Corporate Forecasts of Earnings per Share and Stock Price Behavior : Empirical Tests. *Journal of Accounting Research*, 14(2):246–276.

Perfect, S. B. and Wiles, K. W. (1994). Alternative constructions of Tobin's q : An empirical comparison. *Journal of Empirical Finance*, 1:313–341.

Perold, A. F. (2004). The Capital Asset Pricing Model. *Journal of Economic Perspectives*, 18(3):3–24.

Petajisto, A. (2009). Why Do Demand Curves for Stocks Slope Down? *Journal of Financial and Quantitative Analysis*, 44(05):1013.

Porter, M. E. and Kramer, M. R. (2006). Strategy and Society: The Link Between Competitive Advantage and Corporate Social Responsibility. *Harvard Business Review*, 84(12):78–92.

Porter, M. E. and Kramer, M. R. (2011). Creating Shared Value. *Harvard Business Review*, 89(1/2):62–77.

Rajan, R. G. and Zingales, L. (1998). Financial Dependence and Growth. *The American Economic Review*, 88(3):559–586.

Randall, M., Andrei, S., and Vishny, R. W. (1990). *The Stock Market a and Investment: Is the Market a Sideshow?*, volume 2. The University of Chicago Press, Chicago and London.

Renneboog, L., Terhorst, J., and Zhang, C. (2008). Socially responsible investments: Institutional aspects, performance, and investor behavior. *Journal of Banking & Finance*, 32(9):1723–1742.

Roll, R. (1977). A critique of the asset pricing theory's tests Part I: On past and potential testability of the theory.

Romer, P. (1990). Endogenous Technological Change. *Journal of Political Economy*, 98(5):71–102.

Romer, P. M. (1986). Increasing Returns and Long-Run Growth. *Journal of Political Economy*, 94(5):1002.

Rosenbaum, P. R. and Rubin, D. B. (1983). The central role of the propensity score in observational studies for causal effects. *Biometrika*, 70(1):41–55.

Rouwenhorst, K. G. (1998). International Momentum Strategies. *The Journal of Finance*, LIII(1):267–284.

Russo, M. V. and Fouts, P. A. (1997). A Resource-Based Perspective on Corporate Environmental Performance and Profitability. *The Academy of Management Journal*, 40(3):534–559.

Sauer, D. A. (1997). The impact of social-responsibility screens on investment performance: Evidence from the Domini 400 social index and Domini Equity Mutual Fund. *Review of Financial Economics*, 6(2):137–149.

Schmidt, P. S., Von Arx, U., Schrimpf, A., Wagner, A. F., and Ziegler, A. (2011). On the Construction of Common Size, Value and Momentum Factors in International Stock Markets: A Guide with Applications.

Schmidt, P. S. and Werner, T. (2012). Verified emissions and stock prices: Is there a link? - An empirical analysis of the European Emission Trading Scheme.

Schrimpf, A., Schröder, M., and Stehle, R. (2007). Cross-sectional Tests of Conditional Asset Pricing Models: Evidence from the German Stock Market. *European Financial Management*, 13(5):880–907.

Schröder, M. (2007). Is there a Difference? The Performance Characteristics of SRI Equity Indices. *Journal of Business Finance & Accounting*, 34(1-2):331–348.

Sharpe, W. F. (1963). A Simplified Model for Portfolio Analysis. *Management Science*, 9(2):277–293.

Sharpe, W. F. (1964). Capital Asset Prices: A Theory of Market Equilibrium under Conditions of Risk. *The Journal of Finance*, 19(3):425–442.

Shiller, R. J. (1981a). Do Stock Prices Move Too Much to be Justified by Subsequent Changes in Dividends? *American Economic Review*, 71:421.

Shiller, R. J. (1981b). The Use of Volatility Measures in Assessing Market Efficiency. *The Journal of Finance*, XXXVI(2):291–304.

Siegel, D. S. and Vitaliano, D. F. (2007). An Empirical Analysis of the Strategic Use of Corporate Social Responsibility. *Journal of Economics and Management Strategy*, 13(3):773–792.

Solow, R. M. (1956). A Contribution to the Theory of Economic Growth. *The Quarterly Journal of Economics*, 70(1):65–94.

Solow, R. M. (1974). Intergenerational Equity and Exhaustible Resources. *The Review of Economic Studies*, 41:29–45.

Stambaugh, R. F. (1982). On the exclusion of assets from tests of the two-parameter model.

Stern, N. (2007). *The Economics of Climate Change: The Stern Review*. Cambridge University Press.

Stiglitz, J. (1974a). Growth with Exhaustible Natural Resources: Efficient and Optimal Growth Paths. *The Review of Economic Studies*, 41(1974):123.

Stiglitz, J. E. (1974b). Growth with Exhaustible Natural Resources: The Competitive Economy. *The Review of Economic Studies*, 41:139–152.

Stiglitz, J. E. (1991). The invisible hand and modern welfare economics.

Telle, K. (2006). "It Pays to be Green" - A Premature Conclusion? *Environmental and Resource Economics*, 35(3):195–220.

Teoh, S. H., Welch, I., and Wazzan, C. P. (1999). The Effect of Socially Activist Investment Policies on the Financial Markets: Evidence from the South African Boycott. *The Journal of Business*, 72(1):35–89.

The New York Times (2003). U.S. is pressuring industris to cut greenhouse gases.

Tirole, J. (2001). Corporate Governance. *Econometrica*, 69(1):1–35.

Tirole, J. (2006). *The theory of corporate finance*. Princeton University Press.

Tobin, J. (1969). A General Equilibrium Approach To Monetary Theory. *Journal of Money, Credit and Banking*, 1(1):15–29.

Tonkonogy, B. and Oliva, M. J. (2007). Introduction to the Climate Leaders Program : Introduction for New Partners. Climate Leaders partners Meeting, December 3, 2007. Number December.

US-Sif (2010). Report on Socially Responsible Investing Trends in the United States. Technical report, US Forum for Sustainable and Responsible Investment - Formerly: US Social Investment Forum.

Veith, S., Werner, J. R., and Zimmermann, J. (2009). Capital market response to emission rights returns: Evidence from the European power sector. *Energy Economics*, 31(4):605–613.

Villalonga, B. (2004). Intangible resources, Tobin's q, and sustainability of performance differences. *Journal of Economic Behavior & Organization*, 54(2):205–230.

Wall, L. D. (1995). Some Lessons from Basic Finance for Effective Socially Responsible Investing. *Economic Review - Federal Reserve Bank of Atlanta*, 80(1):1–12.

WBCD and WRI (2004). *The Greenhouse Gas Protocol. A Corporate Accounting and Reporting Standard*. World Bussiness Council for Sustainable Development, World Resource Institut, Geneva, Washingtob DC, revised ve edition.

Windmeijer, F. (2005). A finite sample correction for the variance of linear efficient two-step {GMM} estimators. *Journal of Econometrics*, 126(1):25–51.

Wooldridge, J. M. (2002). *Econometric Analysis of Cross Section and Panel Data*. Cambridge, MA: MIT Press, 1 edition.

Ziegler, A. (2012). Is it Beneficial to be Included in a Sustainability Stock Index? A Panel Data Study for European Firms. *Environmental and Resource Economics*, 52(3):301–325.

Ziegler, A., Busch, T., and Hoffmann, V. H. (2011). Disclosed corporate responses to climate change and stock performance: An international empirical analysis. *Energy Economics*, 33:1283–1294.

Ziegler, A., Eberts, E., Schröder, M., Schulz, A., and Stehle, R. (2007a). Multifaktormodelle zur Erklärung deutscher Aktienrenditen: Eine empirische Analyse. *Schmalenbachs Zeitschrift für betriebswirtschaftliche Forschung*, 59:355–389.

Ziegler, A. and Schröder, M. (2010). What determines the inclusion in a sustainability stock index? *Ecological Economics*, 69(4):848–856.

Ziegler, A., Schröder, M., and Rennings, K. (2007b). The effect of environmental and social performance on the stock performance of european corporations. *Environmental and Resource Economics*, 37(4):661–680.

Zurich Cantonal Bank (2011). Fokus Nachhaltigkeit. Technical report, Zurich Cantonal Bank.

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